THURSDAY, APRIL 28, 1898.

BACTERIOLYSIS OF SEWAGE.

The Purification of Sewage and Water. By W. J. Dibdin, F.I.C., F.C.S., &c., late Chemist and Superintending Gas Examiner to the London County Council and the late Metropolitan Board of Works. Pp. xv + 248. Royal 8vo. (London: The Sanitary Publishing Company, Ltd., 1897.)

RECENTLY there has been an astonishing and sudden revival of interest in the question of the action of bacteria on dead organic matter. Pasteur's experiments on the production of disease by morbific germs were so brilliant that, for long, most workers at the subject kept very much in one groove; still there have always been those who, working very quietly, have been accumulating knowledge concerning the action of bacteria on dead material, and the part these organisms play in the process of disintegration of effete matter.

It has, however, long been known that in nature various processes of purification were undoubtedly intimately associated with the life-history of special groups of bacteria. Certain of these organisms, moreover, have been recognised as playing a most important part in ringing organic material into such condition that it may be readily oxidised; and in both France and England investigators have studied this action, especially in connection with the organisms that are associated with the process of nitrification. It is somewhat remarkable that notwithstanding these numerous experiments, and in spite of the fact that the importance of the part which bacteria play in bringing about natural decomposition, nitrification and similar chemical processes had been so early recognised, no systematic attempt on any large scale had until comparatively recently been made to carry out, artificially, what was recognised as being done on a most extensive scale in nature's laboratory. When once, however, a commencement had been made, the course of events was by no means slow, and many investigators soon turned their attention to the question of the disintegration of the organic matter in sewage, its oxidation and "mineralisation." Amongst these later workers, Mr. W. J. Dibdin has taken an important position, and, in connection with his office as chemist to the London County Council, carried on a series of experiments on the bacterial purification of sewage, which in future will certainly be looked upon as constituting one of the most important parts of the pioneer work on the subject that has been carried out in this country. As the outcome of this work, Mr. Dibdin has published in book form a collected series of articles on the purification of sewage and water; and for those who wish to obtain, in clear and concise form, an account of certain of the bacteriological processes involved in this purification, and who wish to have a summary of the chemical changes and results obtained, no better book is at present published. Now that the question is looked upon as of sufficient importance to demand the appointment of a Royal Commission, to assist the Local Government Board to gather information, some such book as that now before us comes very opportunely. It is fortunate, indeed, that the task of supplying such a book has been undertaken by one whose knowledge of the chemical processes involved is of a very wide and practical character, who has a fair knowledge of the essential details of bacteriology, but who, more important still, has had a very wide experience of the actual working of biological filters. The mass of material accumulated in this book does not at first sight appear, as the conclusions are usually so pithily put, and in such simple language, that the enormous amount of work and systematic observation on which they are founded is sometimes almost lost sight of.

In order to convey some idea of the scope of this work, it may be well to give a brief outline of the ground covered by Mr. Dibdin. After a couple of introductory chapters on the "history of putrefaction" and of the attempts that have, from time to time, been made to interfere with the process of putrefaction in sewage and in river-water, and after describing in some detail the various processes of disinfection, deodorisation, precipitation, and ordinary filtration, a short description of the now famous Massachusetts experiments is given. Then follows a very full account of a series of experiments carried out on the purification of London sewage in biological filter-beds at Barking, and the nature and amount of purification brought about in these filter-beds indicated, the measurement of the purification being taken (*a*) from the amount of oxygen absorbed; (*b*) from the amount of albuminoid ammonia got rid of; and (*c*) the increase in the quantity of nitrates. By passing the sewage intermittently through these filters, and by allowing them to rest and become aerated between the charges, it was found that a purification of from 41 to 85 per cent. was obtained; the whole of the organic matter in suspension was completely removed, and an effluent, in most cases fit to be sent into rivers, was obtained. This purification goes on at the rate of about three-quarters of a million gallons per acre of biological filter.

An installation at Sutton was worked on somewhat similar lines, but here the filtrate from one bacteria tank was passed through a second, in which the filtering material was of finer grain; by this means still better results were obtained, 80 per cent. of purification being about the average obtained. The final filtrates were free from all objectionable odour, and remained perfectly sweet on being kept in either open or closed vessels. At both Barking and Sutton the coarse suspended matter was strained out and buried, and the whole of the subsequent changes were supposed to be due to the action of aerobic organisms.

Mr. Dibdin then gives a description of a system which has been worked out by Scott-Moncrieff at Ashstead, and by Cameron at Exeter, who both use an anaerobic chamber in order to initiate an active preliminary breaking-down of the organic matter in the sewage before aerobic organisms are allowed to act upon it. They hold that in this way a more active disintegration of the organic matter is obtained; whilst, in addition, a process of peptonisation is carried on, with the result that a large quantity of the solid material is quickly thrown into solution, in which form it can be

more readily acted upon by aerobic organisms. It is evident, from the description given and comments made by Mr. Dibdin, that he pins his faith to the aerobic method; though, from the evidence given, it seems probable that the author may in time come to modify his present position.

One of the most interesting sections in the book is that devoted to the description of the various methods by means of which Mr. Dibdin has obtained his results. The description of the micro-filter alone would well repay a perusal of the whole book; the ingenuity exhibited in this simple piece of apparatus marking out Mr. Dibdin as, if not a born, a well-trained experimenter. The methods of determining the amount of nitrates and of oxygen absorbed and dissolved, will appear to the ordinary reader to be considerably less complex and complicated than those usually recommended. This is due, in part, to the fact that some of the processes have undoubtedly been simplified; but it is due still more to the fact that, having worked so much with them, Mr. Dibdin is able to give clear and lucid descriptions of the essential parts of the process without overburdening them with details which, from a practical point of view, are of little importance.

A full description is given of the history of the purification of the Thames from the time that the reaches between Westminster and Waterloo Bridges had their banks covered with accumulations of offensive mud, deposited from water little better than sewage, to the time that fish made their way up the ditches which contained the effluent from the biological filter-tanks at Barking. The whole story is one of engineering, chemistry and bacteriology, set out in plain matter-of-fact form; but Hercules' task of cleansing the Augean stables was mere child's play to the problem that had to be attacked and solved between the years 1855 and 1895. The concluding chapters of the book are taken up with descriptions of some of the methods of ventilation and deodorisation of sewers; with a short account of filtration of potable water; a description of the character of the London water supply; with sections on the action of soft water upon lead; on the application of the biological process to the purification of waste water from private properties, asylums, schools, &c.; and, finally, one on the systematic examination of potable water. Appendices on methods of determining the amount of oxygen dissolved in water, and a detailed report to the London County Council on the experiments on the filtration of sewage effluent during the years 1892-95 complete the work.

Although the reader may not, and probably will not, always agree with Mr. Dibdin, the work on which the conclusions are based appears, in most cases, to be above criticism. The experiments are set out in such form that each one affords ample material on which to base an opinion; the statistics, observations and descriptions are of such a character that not only will they assist in this, but they also give evidence that Mr. Dibdin has made the subject thoroughly his own. His arguments are backed by facts and figures, all the results of careful investigation and of laborious work. The result is that we have a book of far more than ordinary interest, quite apart from the fact that the author has to deal with such interesting matter—a book that may with confidence be recommended to any who take an interest, however slight, in the subject of the bacterial treatment of sewage.

G. S. W.

SCIENCE AND ART OF BUILDING.

Modern Architecture. A book for architects and the public. By H. H. Statham, F.R.I.B.A., Editor of the *Builder*, &c. 8vo, pp. 275. (London: Chapman and Hall, 1897.)

Complete Perspective Course. Britannia Series. By J. Humphrey Spanton. 8vo, pp. 282. (London: Macmillan and Co., 1898.)

Notes on Carpentry and Joinery. By Thomas Jay Evans. 8vo, pp. 396. (London: Chapman and Hall, 1897.)

THE first of these three books suffers from the too prevalent custom of assigning a title to a book that conveys the idea of a greater scope and value than the contents can candidly be said to justify. In the preface the author fairly states the origin of the bulk of the book in a course of lectures delivered to a class of architectural students, not, it is true, previously published, but which, we venture to think, should have appeared in their primary form, possessing all the interest and actuality that such deliverances would have had; without being dressed up with a title that leads the reader to expect a more serious treatment of such an extensive subject as modern architecture.

There are undoubtedly many cultivated people to whom a clear account of modern architecture would be of the greatest interest, inquirers who from time to time, lighting upon some fine modern building, have been puzzled at the qualities which they have felt it to possess, but which are not, at the same time, those of ancient buildings with which the antiquarian leanings of most English people of taste might have made them familiar. Thus made dimly conscious of a new spirit in architecture, they have felt a novel ignorance of the aims and ideals of a modern art, of which very likely they had not been prepared to admit the existence.

A layman is heard to ask an architect, "What style do you call the Imperial Institute?" or "Who was the architect of that fine church of St. Augustine's, Kilburn, which I happened to see the other day?" and so on—questions that show how absolute an ignorance of the development of the architecture of the present day exists even in cultivated circles.

It is to this class, we imagine, that the author intends to appeal as the public mentioned in his title; but the circumstances of the origin of his book in lectures of the kind mentioned above, tells altogether against its usefulness in that respect. It contains a great deal of criticism that was sufficiently useful when directed to the students to whom the lectures were given, but which is out of place in a work addressed to a special class of the public outside.

Again, the author's position as editor of the *Builder* placed at his command a large supply of illustrations for these lectures from the plates of his own journal,

which are here given in a much reduced, and consequently very poorly executed, form; but though the *Builder* retains the leading position amongst architectural papers, it cannot by any means be held to be a fully representative depository of the modern architecture even of England.

Very many of the best buildings never are illustrated at all, either because the architects do not care to publish, or else do not take the trouble to have elaborate drawings made solely for publication; while, on the other hand, there is a flood of second-rate work that is given to the world for obvious commercial reasons.

To rely upon the illustrated journals for a knowledge of modern work is as hopeless as the proceedings of an American critic, who in all good faith tried riding down the main streets of the metropolis on the top of an omnibus, in the expectation of forming an impression of the quality of modern architecture in London.

For a book with this title, the subjects illustrated are too incomplete for it to possess the scientific value that a comprehensive treatise would contain, and in the letterpress the same inadequacy prevails.

The best section is that on State and municipal architecture, the subject that seems to have the greatest interest for the author; but that on the highly important question of domestic work is only slightly treated, and that on church architecture is on lines which, we feel, would hardly be endorsed by those to whom the greatest progress in this branch, in modern times, has been due.

This is not the only section in which the tone of the work is unfortunate. The style in which it is written is hasty and journalistic, and we do not quite like the writer's method of making points by quoting what appears to have been said to him in private conversation, where views are apt to be expressed with a greater vivacity, not to say exaggeration, than the speaker would use in the more deliberate statement of writing.

The truth is, that there is no royal road or cheap handbook to a knowledge of modern architecture. The serious student must hunt up the buildings for himself, even if they are five miles from a railway station. The performances of a great architect are seldom known until his death, and perhaps not even then. The public have no knowledge of Nesfield, Devey, or Bentley, to take three names at random—none of whom, by the way, are mentioned in this book—except that, as regards the last, the writer seems to think that because the new Roman Catholic cathedral drawings have not been given to the *Builder*, that therefore "it is a design about which there is a great reluctance to give any definite information"; a very amusing remark in view of the fact that students interested in the matter have long ago bought copies of a publication in which the scale drawings and full particulars of this remarkable design have been given.

The book on perspective is one of those innumerable works that the modern craze for examination produces; it is designed to meet, as quoted on the title-page, the requirements of four examining bodies, and as the author is instructor to the Royal Naval cadets on the *Britannia*, he has the necessary teaching experience to make his work likely to be helpful to the unlucky souls condemned to these examinations. To the architect, for whom also the book is intended, perspective should present itself as an almost indispensable accomplishment, but one which it is also far more important to acquire through practice than theory. It is a rule that in perspective drawing, there are many ways of arriving at the desired result; and as a matter of fact, except in a few universal points, most draughtsmen have their own methods of reaching a given result. We never yet met a student who used the method given in Chapter xii. for making a sketch, but possibly it might be of service to a beginner. As specimens of drawings—a rather important, though neglected point—the illustrations leave something to be desired, and when architecture is given the design is also not the best selected. This, unfortunately however, is universal in many text-books. In Chapter xvi. the defects of perspective in photography are explained, and a useful method of correction is given, constituting a good feature of the work.

A diagram is also given of how to set a centrolinead, showing the increasing value attached to this useful instrument, which every student should be taught to handle.

The book is clearly arranged and well referenced, which is an important point for actual use, because whatever method of perspective setting-up the student uses, it is indispensable that he shou'd have it at his fingers' ends, so that he may not be hampered in devoting himself to an artistic result in his drawing; but, inasmuch as the memory is apt to be treacherous in such matters, facility of reference is an invaluable saving of time.

The volume on carpentry and joinery has also been written with the special object of preparing for examinations, and the present work refers to the first or preliminary course of the City and Guilds Institute, which is dealt with from a practical point of view; but a better title would be "mensuration, physics, plane and solid geometry, &c., as applied to carpentry, &c.," the bulk of the volume being taken up with these subjects. The book forms a good introduction to the subject, which we welcome as a method and an inducement for the British craftsman to study his craft in a more scientific manner than has been the case in the past. One or two points might be revised. Fig. 53 shows a pointed arch in stone which is scientifically wrong, as the meeting of the two arches should be a straight joint in order that each section may move independently without causing a fracture. Problem No. 90 could be described accurately instead of approximately by the "trammel" method, as indeed is explained in Problem 91. It is, perhaps, advisable to adhere only to exact methods for the workman, as he is liable to get muddled between two methods.

The exercises placed at the end of each chapter are well arranged, and should teach the workman to think for himself—a most important point.

Some misprints are, perhaps, inevitable where so many figures and letters are introduced, as 39° for 30° on p. 169. The chapter on isometric projection will be found very useful for explaining joints, &c., but the lettering to the diagrams is not as distinct as it might be, and could be improved by the author if a future edition is required. The chapters on setting out of

doors and windows are well arranged, but the joints at the feet of principal rafter and tie-beam in Figs. 245, 246, 247 and 248, will not, it is hoped, be repeated in succeeding volumes. The chapters on the resolution of forces, mechanical contrivances, bending moments, &c., give a prominent place to the scientific part of the subject, a study which we can with confidence advise the craftsman to undertake. The chapter on the determination of stresses might be made somewhat clearer, having regard to the class of man for whom the book is intended, if the author would take the forces acting at any point always in the same order, and work round with the sun. Under "mechanical contrivances" no mention appears to be made of the screw, which is specially mentioned in the syllabus. We refer with regret to the fact that there is no index, which detracts materially from the value of a well-arranged book.

A GERMAN POPULAR ASTRONOMY.

Das Weltgebäude.—Eine gemeinverständliche Himmelskunde. Von Dr. M. Wilhelm Meyer. Mit 287 Abbildungen im Text, 10 Karten, und 31 Tafeln, im Farbendruck, Heliogravüre und Holzschnitt. (Leipzig und Wien: Bibliographisches Institut, 1898.)

IN a very handsome volume, well written, well printed, and well illustrated, Dr. Meyer has given us the main results of astronomical observation. We may congratulate both the author and his readers on the selection of the facts that has been made, and submitted to consideration. The arrangement of the material has evidently been the subject of much care and thought; but we cannot say that the final result commends itself entirely to our judgment. In a short preface, Dr. Meyer has intimated the general principles by which he has been guided in preparing his work. He has wished the reader to appreciate the grounds on which certain truths have been received, and not simply accept the assertions as an outcome of authoritative teaching. He admits that without mathematical symbols and analysis it may be difficult to offer direct proof in support of many statements; but by translating the results of mathematical deductions into the language of ordinary life, he thinks it possible to find an efficient substitute. It is not without a feeling of apprehension that one reads of threats of this kind. Efforts to reproduce mathematical results without the use of the necessary machinery generally prove wearisome to the mathematician, and unintelligible to the ordinary reader. But Dr. Meyer has not taken the matter too seriously, and even in his chapter on the Newtonian system avoids the perils of adhering too closely to his own principles.

The author has divided his book into two parts. The first is descriptive, and in this section his endeavour is to describe the whole universe as it may be seen with instruments particularly designed for special ends. The causes for these appearances, or the theories by which they may be explained, are reserved for the second part. Whether such an arrangement is satisfactory can only be decided by the student. To any one who approaches the book with a fair amount of astronomical knowledge, it appears cut in halves, without sufficient reason. As it is impossible within a limited space to describe each section separately, the author's method of treatment may be illustrated by referring to the description of the moon, given in the first section, immediately after describing, not at too great length, but adequately, the telescope and spectroscope and the processes of photography and photometry. We have first of all an account of the phases, for the detection of which no telescope is necessary, and for whose correct explanation but little ingenuity is required. The instrumental examination of the moon begins with the application of the spectroscope to the light, and the obvious deductions that follow its use are necessarily given. Having discussed the absence of an atmosphere, the effect of the sun's heat, &c., we get to the telescope and trace historically the cartography of the moon from Hevel to Schmidt. Finally, and also following chronological order, we reach the age of photography and the delineations of Weinek from the Lick negatives, many of which are reproduced. Particularly good and interesting are the comparisons instituted between portions of the lunar surface and certain districts on the earth, not by any means with the view of suggesting that the configurations have been produced by similar processes in each case, but as a convenient way of illustrating points of resemblance or emphasising points of difference. The Island of Corsica, the Colorado Cañon, the Yosemite Valley are all in turn discussed and made to illustrate some generic feature on the lunar surface. Altogether it is the best description of the moon we have read; and it is only when we come to remember what is omitted, that we have any sense of dissatisfaction. For instance, we find nothing about the distance of the moon, though the diameter is given. This is surely a departure from the rule to be purely descriptive, though the description gains immensely by it, since it enables comparisons to be drawn between similar features on the earth. Moreover, while the distance remains undetermined, the diameter must be taken on authority; and this is opposed to the fundamental canon of the preface. The geometry of eclipses has to be relegated to the second part, similarly with other phenomena depending upon the mass of the moon, such as the action of the tides or the effects of precession and nutation. The advantage of the arrangement does not seem evident, nor does it entirely fulfil the purpose for which it was designed, although each part is admirable in itself, but wanting in completeness and connection. The method pursued with the moon is continued throughout the solar system, though of course there is not always the same necessity to return to omitted portions. From the members of the solar system we pass to comets and meteors, and finally to the universe of the fixed stars. It goes without saying that these chapters are not only correct, but offer us the latest information drawn, as they are, from experts in their several branches of investigation. For the author, distrustful of his own knowledge, and remembering that the fact of to-day is liable to be displaced by the newer discovery of to-morrow, prudently placed his manuscript for correction in the hands of various authorities. Thus, Schiaparelli either describes or confirms the description of Mars, and Dr. Scheiner, of Potsdam, is responsible for the accuracy of the chapters on spectrum analysis. Dr. Ginzel, who has written so largely on ancient chronology, is willing to assist here in the discussion of eclipses, while Dr.

Seeliger, it is admitted, has by his suggestions and revision materially improved the chapter on gravity. If the section on telescopes had also been overlooked by a competent authority, perhaps Herschel's giant telescope would have been erected at Slough rather than at Bath; but wherever these eminent authorities have co-operated with the author, it is needless to say that we have an admirable result, correct in all important particulars.

As an example of the character of the second part of the work, entitled "Motion of the Celestial Bodies," we select the chapter on the figure of the earth. We make this selection the more readily because it affords an apt instance, not only of the successful treatment of a difficult subject, but illustrates the thoroughness attempted in German popular works. In English books of similar character the tendency is rather to adhere to subjects that lend themselves to pictorial illustrations of an interesting kind, or are capable of easy description, making no great demand upon the attention. Sir Robert Ball, it is true, has given us some charming chapters on the wanderings of the Pole, but writers who wield a less facile pen have generally left the subjects connected with geodetic measurements severely alone. In the Ipswich Lectures, Airy taught us how a base line was measured, and how triangulation was effected; but his example has not been generally followed. Newer methods and more sensational results have swallowed up the interest that once belonged to the science of exact measurement. But to Dr. Meyer the subject is not unwelcome. Adhering to his general plan of first showing the main principles underlying any process, without introducing needless niceties invented to provide against sources of error, he keeps the attention of the reader fixed on the main object of the investigation, without being lost in the intricacies of detail. In this way we see how latitude and longitude are determined, the gradual elimination of errors from the observations, and the regular approach to scientific accuracy. There is nothing wearisome in the account of triangulation, for it is brightened and relieved here and there by references to ancient history, to past expeditions, and the results of previous measurements. As might be anticipated, one does not find much reference to English work, that is not the object of the book; it is not the history of results, but the history of methods that is under consideration, and the countryman of Bessel can find all he wants in the writings of that astronomer and in the work of the "Europäischen Gradmessung." The deviations of the earth's figure from that of the surface of an ellipsoid of revolution, and the variation of gravity with the causes that contribute to it, are set out in great detail, showing that the author expects an audience of very considerable intelligence to follow him. This is a point that constitutes for us the real interest of the book, the evidence it affords of the existence of more general information than is usually to be met with in English readers. The author must have been aware of the eagerness of a large class to possess exact information, and has catered for it; but we cannot imagine that this book would enjoy a very large circulation in this country. Between the mathematical reader and the "man in the street" there is a great gulf fixed, which works of this character are calculated to bridge, but which at present find no great support from either description of reader. W. E. P.

OUR BOOK SHELF.

La Vie: Mode de Mouvement. Essai d'une Théorie Physique des Phénomènes Vitaux. Par E. Préaubert, Professeur an Lycée d'Angers, &c. Pp. 310. (Paris: Félix Alcan, 1897.)

WE can hardly suppose that M. Préaubert intends his remarkable speculation to be taken seriously. His contention is that life is essentially a mode of motion of the ether, and as such is closely allied with electricity and magnetism; finding, like these forces, its expression but not its origin in ponderable matter. It is, he maintains, in consequence of the failure to recognise the ether as the true seat of vital activity that all attempts to explain the phenomena of life on a purely chemical or physical basis have hitherto broken down. With the removal of "vitality" to the region of the ether, the material difficulties vanish; the connection between vitality and the other forces of the physical universe becomes declared, and biology resolves itself essentially into a mere question of mechanics. What then is the true distinction between life, on the one hand, and light, radiant heat and electricity on the other? The author answers that life is a series, not of vibrations, but of vortex-movements; his discovery, in fact, could hardly be better expressed than in the words of the puzzle-headed old Athenian in the "Clouds"—

Δῖνος βασιλεύει, τὸν Δί' ἐξεληλακώς.

It need, perhaps, scarcely be said that in support of his central position he has nothing to offer but a collection of assumptions and analogies, the former practically baseless, and the latter more or less loose. He seems, indeed, to forget in practice, though he recognises in words, the distinction between analogy and identity; and anything deserving the name of proof is conspicuously lacking. Space will not allow us to deal with his statements in detail; he commits himself to many that would be called in question by both physiologists and morphologists. We cannot, however, refrain from expressing our wonder that so many writers on evolution should virtually ignore the firm foundation laid by Darwin. So far as M. Préaubert's biological arguments are concerned, the theory of natural selection might almost as well be non-existent.

We doubted at the outset whether the author expected to be taken seriously. His closing passage contains what is in effect a *reductio ad absurdum* of his whole theory. F. A. D.

The Barometrical Determination of Heights. By F. J. B. Cordeiro, Surgeon U.S. Navy. Pp. 28. (London: E. and F. N. Spon, Ltd., 1898.)

IN the calculation of mountain heights by means of the mercurial barometer, accuracy depends on the efficiency of the formulæ employed. These formulæ are based necessarily on assumptions, as we do not know exactly the varying conditions of the air, and we therefore fail to take into account the exact data for the correct solution of the problem. As a rule, the formulæ are at most only approximations; but it is astonishing what good results may be obtained by paying strict attention to all details.

In this neatly bound little book we have an essay on this subject, which was originally entered in the Hodgkin Prize Competition under the auspices of the Smithsonian Institution, and was awarded honourable mention. The author has briefly brought up to date the problem of barometrical hypsometry discussed many years ago by Guyot. He points out where the old theories were lacking in accuracy, and furnishes a method which, besides being rigidly correct in theory, gives trustworthy results in practice. As an illustration of this, a series of observations is added. In the appendix the author describes a form of

air barometer, the advantages of which over a mercurial barometer are compactness and portability, greater sensitiveness, greater simplicity in the calculations, and, lastly, greater cheapness.

All those who are interested in the measurement of heights by barometric methods should read these twenty-eight pages.

Laboratory Directions in General Biology. By Harriet Randolph, Ph.D., Demonstrator in Biology and Reader in Botany, Bryn Mawr College. (New York: H. Holt and Co., 1897.)

THIS booklet of 152 pages small octavo is a guide to a 142 hours' elementary laboratory course. The Fern and Earthworm are first dealt with, and then a series of animal and vegetable forms, in ascending order determined by convenience, the whole culminating in a small modicum of comparative embryology. Directions for manipulation are throughout rendered in italics. Of the making of books there is no end, but a pity 'tis that of the making of books such as this should be a beginning! The whole is but a set of rough laboratory notes of the time-table order, such as are everywhere used under prevailing custom and often destroyed when done with. They are of the kind justified only by the necessity for local adaptation of class work; but of this there is here no evidence, and we consequently regard their publication in book-form as superfluous.

The Freezing-Point, Boiling-Point and Conductivity Methods. By Harry C. Jones. Pp. vii + 64. (Easton, Pa.: Chemical Publishing Co., 1897.)

THIS little laboratory handbook is designed not merely as a guide to the manipulation of the methods of which it treats, but also to give the student an insight into the physical principles underlying them. The theoretical part is, however, in many places so compressed that, it is to be feared, the average student will hardly be able to follow it without some previous knowledge of the subject derived from other sources. The practical part is, on the other hand, very well done. It includes descriptions of Beckmann's and the author's apparatus for the determination of freezing-points of solutions, of the Beckmann boiling-point apparatus, as well as of the later forms devised by Hite and by the author, and of the Kohlrausch apparatus for the determination of the conductivity of solutions in the form described by Ostwald. The details of manipulation, on which the author's extensive practical experience of these methods entitles him to speak with some authority, should secure a hearty welcome for this book wherever laboratory instruction in physical chemistry is given.

Philip's Artistic Fruit Studies. By R. H. Wright. *Philip's Artistic Animal Studies.* By H. A. K. Dixon. (London: George Philip and Son, 1898.)

IN the lower standards of Elementary Schools the children are given various occupations, such as plaiting, crayon drawing, and macrami work, having for its object the training of the hand and eye. The collections of plant and animal studies now before us have been arranged for this purpose, and they will afford the young pupils for whom they are intended both pleasure and instruction. Each collection consists of a series of twelve original designs, simply coloured, and a series of twelve outline drawings for colouring with crayons or paints. From the fruit studies the children will learn a few details concerning common fruits; and the animal studies, containing coloured drawings of queen, male and neuter bees, the development of the frog, and similar subjects will be of value in interesting the pupils in natural history.

It would be an advantage to young pupils if the name of the object were in every case distinctly printed under both the outline and coloured drawings.

LETTER TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

"The Story of Gloucester."

MAY I ask the courtesy of a few words in further consideration of this, not in reply to your contributor, but as a plea for a little consideration to a few thoughts entertained by thousands on the other side of this controversy?

Let all the advocates of vaccination reflect that there is in the small-pox a disorder that affects the skin. That this serious damage to the skin is the real reason of the danger of the disorder; and that this damage to the skin makes any classification by skin marks a very unscientific and a very imperfect manner of dividing the cases. It is more serious than that. It makes classification by skin marks of vaccination almost certain to be erroneous. No certainty of correctness can be had, except in the mildest of the cases. In all the confluent cases, classification of the small-pox cases by skin marks will be in error with certainty. Therefore, as there has always been a most positive refusal to refer to the register of vaccinations, we have not the slightest reason for accepting the classification of hospital small-pox as correct. We have however, no other classification. We therefore must, perforce, accept for argument that classification. But we always do it with reserve.

These remarks are those which occur to us always in looking at the modern (post-vaccination) unvaccinated fatalities. If you are making a set of fatalities, which are enormously heavier than ever were recorded before Jenner began his vaccinations, then you are entitled to ask if there is in the fatality, taken as a whole, any justification for these unvaccinated fatalities, such as are now shown.

	Per cent.
Thus, Von Swieten's fatalities 150 years ago were under	2
The accepted fatality in this country before vaccination was	16
The Royal Commissioners give Chester, 1774 ...	16 8
" " " Ware, 1722 ...	11·7
" " " Old Small-pox Hospital, 1746 63 ...	25·3

This last is the very highest I have ever been able to find. And it is fully accounted for by the statement made in the report of the hospital in explanation of it, that "most of them were adults, often admitted after great irregularities, and some when their cure was despaired of." The hospital was small, and there was not a general admission of patients. Only free admission was allowed for those who were to have the inoculated small-pox. We have then to set against those fatalities, which are exhibited, for the most part, as showing how serious a loss of life was risked by the non-inoculated, the fatality of our own hospitals since the enforcement of vaccination. Thus—

	Per cent. died.
Metropolitan Hospital, 1870-72	18·6
Homerton Hospital, 1871-77	19·43
Metropolitan Hospitals, 1876	23
Same Hospitals for 1876-1880	17 3
Dublin, 1876-1880	21·7

In the recent years, as there has been a crowding of all the cases into hospitals, and a great deal of hospital extension—never known previously—we have a rather lower rate, as was to be expected: thus—

	Died per cent.
Fulham, 1879	16·2
Metropolitan Hospitals, 1884	15·8
Fulham, however, for 1885 was	24·3
And for Gloucester we have, 1895-96 ...	21·9

There is here nothing to boast of in the fatalities of our compulsory vaccination period. There is never so low a fatality as that recorded by Von Swieten, or by Isaac Massey at Christ's Hospital, where only one child in some hundreds died (1722), and there is no avoiding the conclusion, that I can see, that if on the whole there is no lessened fatality, there is some error in the division, which makes one set appear to be vastly better off than the other. I have tested that in this way in the Gloucester cases, by asking if there was a single class free from fatality?

The answer is, of course, that there is not one. Government exacts multiple marks of vaccination, but in Gloucester it is clear that there was a better case for the single than for the multiple marks. Government exacts re-vaccination in the services, but here there is a large number of re-vaccinated cases, and twice Von Swieten's fatality in them.

Then, again, it is clear that the eruption has, as of old, everything to do with the fatality, and nothing can be clearer in the Gloucester cases. Unless, therefore, you have taken the precaution of giving reference to the register of vaccinations, you are in the fix of having almost certainly got wrong with your classification. Is there any test of this? There most certainly is. For in the variety of the disease, in which there is not so much damage to the skin as discoloration of it, where the poison is damaging the whole system, and internally more than externally, we have still the vaccination marks, if they are noted. I gave before the Commissioners all these cases that I had been able to trace in a large number of reports. And here is the fatality of these "malignant" cases.

	Per cent. died.
Vaccinated malignant cases	83·5
Unvaccinated cases	90
The first line divides thus—	
Vaccinated, no evidence	82
Doubtfully vaccinated	81
Indifferent vaccination marks	84
Good vaccination marks	85

It is very clear, therefore, that there is not the slightest influence in vaccination, good, bad, or indifferent, to abate the fatality of these cases. In some of the hospitals the whole of the vaccinated in this class died, without any recoveries. But that way of returning the cases is only followed occasionally, so that there is no possibility of taking all the hospital experience. There is however, no reason to suppose that it would show any different results. All these cases, with the almost unvarying total fatality, show that there is high time for a reference of every possible case returned as unvaccinated to the vaccination officer for his verification, and for information as to whether there had been the payment for successful vaccination. Till that is done, we have the right to say that there is not the slightest gain accruing from vaccination in the cures of the small-pox, and that there is all reason for declaring the present classification by skin marks in this eruptive disease unscientific and erroneous. ALEX. WHEELER.

Darlington, April 17.

[In deference to the wishes of Mr. Wheeler we print the enclosed letter, after which our columns must be closed to the subject unless something very important is brought forward. Of course, as Mr. Wheeler says, he has completely departed from the original controversy; and it is necessary to call attention to the fact that no amount of statistical jugglery, or reference to assumed historical data, can be held sufficient to refute the unquestioned fact that in Gloucester the unvaccinated children were attacked with small-pox and died in overwhelming disproportion to the vaccinated. Epidemics, as we know, cannot be compared with one another as regards their severity, but the incidence of attack in the same epidemic may always be taken as being fairly comparable throughout.—ED. NATURE.]

RÖNTGEN RAYS AND ORDINARY LIGHT.

ACCORDING to the theory of the Röntgen rays suggested by Sir G. Stokes,[1] and recently developed by Prof J. J. Thomson,[2] their origin is to be sought in impacts of the charged atoms constituting the kathode-stream, whereby pulses of disturbance are generated in the ether. This theory has certainly much to recommend it; but I cannot see that it carries with it some of the consequences which have been deduced as to the distinction between Röntgen rays and ordinary luminous and non-luminous radiation. The conclusion of the authors above mentioned,[3] "that the Röntgen rays are not waves of very short wave-length, but impulses," surprises me. From the fact of their being highly condensed impulses, I should conclude on the contrary that they *are* waves of short wave-length. If short waves are inadmissible, longer waves are still more inadmissible. What then becomes of Fourier's theorem and its assertion that *any* disturbance may be analysed into regular waves?

Is it contended that previous to resolution (whether merely theoretical, or practically effected by the spectroscope) the vibrations of ordinary (*e.g.* white) light are regular, and thus distinguished from disturbances made up of impulses? This view was certainly supported in the past by high authorities, but it has been shown to be untenable by Gouy,[1] Schuster,[2] and the present writer.[3] A curve representative of white light, if it were drawn upon paper, would show no sequences of similar waves.

In the second of the papers referred to, I endeavoured to show in detail that white light might be supposed to have the very constitution now ascribed to the Röntgen radiation, except that of course the impulses would have to be less condensed. The peculiar behaviour of the Röntgen radiation with respect to diffraction and refraction would thus be attributable merely to the extreme shortness of the waves composing it. RAYLEIGH.

April 18.

[1] *Manchester Memoirs*, vol. xli. No. 15, 1897.
[2] *Phil. Mag.*, vol. xlv. p. 172, 1898.
[3] See also Prof. S. P. Thompson's "Light Visible and Invisible" (London, 1897), p. 273.

THE BAKERIAN LECTURE.[4]

THE purpose of the lecture was to show that certain metals and certain organic bodies can act on a photographic plate in such a manner that, on treating it exactly as if it had been acted on by light, a picture is developed. When carrying on some experiments with photographic plates, a piece of perforated zinc was found not to act as a screen and give a picture of the holes, but to give a picture of the metallic part; and further, it was found that a bright piece of zinc, when coated with copal varnish, with the object of stopping any emanation of vapour from it, became more, not less, active; these were the accidental observations which gave rise to the present investigation. With regard to the action of the organic bodies: their activity is greater than that of the metals, and the experiments with them are more easily carried out, hence it was advisable to investigate to a considerable extent their action before undertaking the more intricate and, probably, more important action of the metals.

Printing ink is one of the many substances which will, both when in contact and when at a distance, act on a photographic plate, and it was shown that remarkably clear pictures can be obtained of ordinary printing and of lithographic pictures. Printing ink varies in composition, and if the ordinary newspaper's, for instance, be used, the density of the pictures obtained will vary considerably. The varnish known as picture copal is also an active substance producing a dark picture. The active constituent of the printing ink was proved to be boiled oil, and in the varnish to be turpentine; and these bodies alone can be used in place of the more complicated substance above named. If then boiled or drying oil was active, it was natural to try linseed oil in its ordinary state, and this proved also to be active; different specimens, however, of so-called pure oil vary very considerably in the amount of their activity. Passing from linseed oil to other vegetable oils, they were found also to be active, but apparently none so active as the linseed oil. Then, with regard to turpentine, a body belonging to a very different class of organic substances, it was found that bodies analogous to it—all the terpines,

[1] *Journal de Physique*, 1886, p. 354.
[2] *Phil. Mag.*, vol. xxxvii. p. 509, 1894.
[3] Enc. Brit., Art. "Wave Theory," 1888; *Phil. Mag.*, vol. xxvii. p. 461, 1889.
[4] Delivered before the Royal Society, March 24, by Dr. W. J. Russell, V.P.R.S.

for instance—were exceedingly active bodies; and it is interesting to note that with some of them an effect on the sensitive plate, analogous to what photographers term reversal or solarisation, is readily produced. With excessive action, a white in place of a black picture is obtained, but with modified action an ordinary dark picture is formed. All the fragrant essential oils are active bodies, and all contain as an ingredient one or more of the terpines. Now a characteristic property common to all the above-named bodies, and to others which produce similar effects on a photographic plate, is that they are reducing or oxygen absorbing bodies; consequently it is probable that it is to this property that they owe their power of acting on a photographic plate. Bodies such as alcohol, ether, esters, benzene, petroleum spirit, &c., exert no such action. Linseed oil is the most active of the vegetable oils, and has the greatest oxygen-absorbing power, olive oil the least, and it can produce little or no action on a photographic plate. An interesting test as to certain impurities in inactive bodies, for instance in alcohol and in ether, can be founded on these reactions. Ordinary commercial samples of these bodies, when placed in a dish with a photographic plate above them, yield a picture; but on carefully applying the ordinary processes for purifying these bodies, the pictures produced become fainter and fainter, and at last entirely disappear, so that not only the process of purification can be rendered visible step by step, but its completion be proved. One remarkably interesting character of these actions is, that they can take place through thin layers of certain solid substances; for instance, through gelatin, celluloid, collodion, gutta-percha tissue, gold-beater's skin, tracing-paper, &c., and naturally the action permeates paper and other strongly porous bodies. In so doing it gives on the sensitive plate a picture of the structure of the body. That the passing through a medium such as gelatin is not one of mere absorption on one side and evaporation on the other, is proved by the formation, after having passed through the medium, of a clear picture of the surface, say hardened copal varnish, from which the action arose; and even when more than a single layer of gelatin is interposed between the active body and the plate, still a clear picture is produced. On the other hand, bodies such as glass, mica, and selenite are perfectly opaque to the action, and gum arabic and paraffin in thin layers do not allow the action to pass through. Experiments were described in the lecture to show that it is a vapour given off by the active bodies which is the immediate cause of the action on the photographic plate, not a fluorescence emanating from the active body. A card, for instance, painted with drying oil or copal varnish, smaller than the photographic plate, and placed below a sensitive plate with the film upwards, produces an action round the edge of the plate, which creeps slowly and unevenly towards the centre. An arrangement was also described with a series of mica plates, overlapping one another so as to cut off all direct view of the active body from the sensitive plate, but so arranged as to allow a space between each layer, so that a vapour could work its way from the source of the action to the sensitive film. Such an arrangement enclosed in a box produced a definite picture.

It was naturally to be expected that an inactive substance, such, for instance, as a piece of Bristol board, could be made active by placing it in contact with hardened drying oil or copal varnish, or simply by placing it over linseed oil or turpentine; and the Bristol board, although no change in the surface is visible, will now produce a definite picture. High temperatures cannot, of course, be used with photographic plates. Many experiments have, however, been made at 55° C., and the action at this temperature as compared to that at ordinary temperatures show that a very great increase of activity takes place with the increase of temperature.

Experiments similar to those which have been indicated as having been made with organic bodies, have also been made with the different active metals, and similar results obtained. Zinc is, perhaps, the most convenient metal to experiment with. That it possesses this property of acting on a photographic plate was first published by M. Colson, but unknown to the lecturer until after his first set of experiments were made. The following is a list of the metals which have been found to be most active, and they are arranged approximately in the order of their activity. Magnesium, cadmium, zinc, nickel, aluminium, lead, bismuth; then follows cobalt, tin, antimony, which are decidedly less active than the foregoing ones; and there are others which with very long exposure show some amount of activity. Again certain alloys, such as pewter and fusible metal, are active bodies, whereas ordinary brass and german silver are not so. Increase the amount of zinc in brass, and it becomes an active alloy. The conditions under which this change occurs are being investigated. From the first experiments which were made it was concluded that mercury was an exceedingly active metal, but it has since been proved that it is entirely inactive, and that the action previously obtained was due to the metal being alloyed with a trace of zinc. That an exceedingly small amount of zinc is capable of effecting this change in mercury, is an interesting and important fact. This action can also be utilised as a test for the absence both of zinc and lead (for this metal acts in the same way as zinc) in a specimen of mercury, and pictures were shown which exhibited the effect of several of the ordinary purifying processes on impure mercury.

In order to show that the action exerted by the metals is due to a vapour, as before stated, experiments similar to those made with the organic bodies, and other ones described in the lecture, have been carried out. For a metal surface to be active it must be bright; a piece of dull zinc, for instance, exerts no action on the photographic plate, but rub it with coarse sand or emery paper, and you get a surface which will give an exact picture of every line that is visible on the plate, and even when a sheet of gelatin or celluloid is interposed, still a picture of the metal surface is formed. As a further confirmation of the view that a vapour is given off by the metal, it was shown that a slow current of air passed over bright zinc and allowed to impinge on a photographic plate, acted on it and produced a picture. Interesting pictures of opaque bodies are readily produced by placing a plate of polished zinc behind them, and in this way, for instance, the structure of different papers and the water-marks they bear, the form of skeleton-leaves, &c., are obtained as pictures. The opacity which certain solutions give to paper, and the transparency which others communicate to it, is of much interest, and further experiments are being made on this branch of the subject.

Another curious action was mentioned, which is that zinc and other metals have the power of making certain inactive liquids active. If, for instance, alcohol or ether or acetic ether be digested for four days with bright zinc, it will become active and capable of producing a picture; filtration and even distillation does not restore the inactivity of the solution.

It appears then that many substances, both organic and metallic, are able to act on a sensitive photographic plate, and that exceedingly small quantities of these active bodies are sufficient to produce the effect. A piece of board laid on a sensitive plate will give a good picture of its structure, and even thin dry board 30 to 100 years old can be made to give its likeness. Dry cinnamon and many other bodies act in the same way. Other experiments were described showing how an accumulation of the active vapour from zinc could be demonstrated, and, further, how the vapour was reflected from the sides of a glass or paraffin tube, but absorbed by a paper one. The

foregoing outline shows some of the principal points described in the lecture. The subject is a far extending one, and it is more important at the present time to obtain accurate data than to suggest theories; many other interesting points have, in fact, already been determined. The lecturer noted that the above experiments had been made in the Davy-Faraday Laboratory.

ANDRÉE'S BALLOON EXPEDITION.[1]

ALTHOUGH the fact is not stated, this is a translation, and a singularly literal one, of the French original. It is to be regretted that obvious printer's errors or slips of the pen were not corrected; for example, "1892" for "1882" on p. 14, "south" for "north" on p. 280, and the somewhat serious misstatement of Andrée's last message on p. 10, which is the least excusable, as a facsimile with correct translation attached is given on p. 306. On p. 168 the translator computes 5000 cubic metres at 17,658 cubic feet instead of 176,580. A somewhat infelicitous if not unintelligible paraphrase of marking a pigeon's feathers with an india-rubber stamp, is fixing on labels by the aid of india-rubber wafers (p. 233). It must be stated, on the other hand, that the English edition is much better printed than the French, especially as regards the extremely interesting plates, and that it contains an effective coloured frontispiece showing the departure of the balloon.

The narrative is in two parts. The first, by M. Lachambre, describes the balloon and the process of its manufacture, the transport of the material to Dane's Island in 1896, the erection of a shed, the inflation of the balloon, the long waiting for a favourable wind, the deflation and return. The second part, by M. Machuron, the nephew and partner of M. Lachambre, describes the transport of the enlarged balloon to Dane's Island in 1897, the repair of the shed, re-inflation, and the casting off on July 11. Both authors describe their own work clearly and well. They have nothing to say as to Andrée's plans, his theory of circumpolar prevailing winds, or his probable fate. But the technicalities of balloon construction, and the dexterous manipulations of the delicate fabric as it was prepared far from workshops or extraneous help, are lightened by the ingenuous impressions of the two intelligent Parisians suddenly transported into so strange a world.

The balloon *Ornen* was constructed as a sphere sixty-six feet in diameter with a conical appendage. It was furnished with two lateral valves for releasing the imprisoned gas at will, a large automatic valve to let the gas escape whenever the internal pressure exceeded a certain limit, and a rending flap intended to be used to prevent bumping on finally alighting, and so constructed that a rope attached to a small grapnel, on being thrown to the ground, would tear a great rent in the side of the balloon, deflating it instantaneously. The cubic contents were 160,000 cubic feet; but this was increased for the second attempt to 176,000 cubic feet. The material used was pongee silk of double, triple, or quadruple thickness, according to the part of the balloon and the strain to which it would be subjected. The silk was prepared in pieces of about 18 inches in width, and the balloon was made up of horizontal zones, the joints of each successive zone being alternate, as in brickwork. When completed the whole was thoroughly and repeatedly varnished inside and outside. While both Andrée and the manufacturers were confident of the gas-retaining power of such a construction, we understand that some experienced aeronauts view it with great suspicion, and greatly prefer the old system of vertical gores. The wicker car was fitted up with marvellous ingenuity, and attached by a ring to a cord net thrown over the balloon. A cap of varnished silk on the top of the

FIG. 1.—The top of the balloon, showing the joinings of the pieces.

[1] "Andrée and his Balloon." By Henri Lachambre and Alexis Machuron. With coloured frontispiece and 44 full-page illustrations from photographs. Pp. 306. (Westminster: Archibald Constable and Co., 1898.)

balloon protected the net from snow. Andrée's plan was to keep the balloon within a few hundred feet of the ground by the use of heavy guide-ropes dragging over the ice or through the sea, a device which serves as an automatic regulator of height.

The erection of the balloon-shed, gas-generators, and the inflation of the balloon in the far north of Spitsbergen formed a very neat piece of engineering, of which the Paris firm and their Swedish colleagues may well be proud. We may recall the facts of the departure. The balloon glided through the demolished north side of its shed at 2.30 p.m. on Sunday, July 11, 1897, and slowly swept northwards across the bay and over the low hills on the horizon. The last authentic pigeon-message received runs: "July 13. 12.30 p.m. 82° 2′ N. lat., 15° 5′ E. long. Good journey E. 10° S. All well on board. This is the third pigeon-post.—ANDRÉE."

Beyond this all is conjecture; but before adopting pessimistic views as to the fate of Andrée, Strindberg and Fraenkel, we should remember how few believed in July 1896 that the *Fram* would ever return. There is still hope for the crew of the *Ornen*.

HUGH ROBERT MILL.

FIG. 2.—The balloon on its departure, showing guide-ropes.

THE BENEKE PRIZES.

THE Philosophical Faculty of the Georg-Augusts-University of Göttingen has just published the following information concerning the Beneke prizes for the years 1897 and 1901. On March 11, 1898, the birthday of Carl Gustav Beneke the founder of this prize, it was announced that no communication had been sent in for the prize competition for the year 1897. At the same time the Philosophical Faculty set the following problem for the year 1901.

The principle of continuity, or more exactly the representation by functions which can be indefinitely differentiated, has for a long time been regarded as a general valid foundation for the mathematical treatment of natural phenomena. Such a groundwork as this was quite naturally introduced by the discoverers of the differential and integral calculus. More recently, however, the progress of mathematical investigation has shown generally that this is founded on a great number of implicit suppositions to which we, in consequence of the inaccuracies of our sensitive perceptions, are not bound. Further, the assumption of the molecular constitution of matter is from the first in contradiction with well-known laws.

The Faculty wishes to receive a work of real scientific interest in which such questions will be treated in a general intelligent way, and in which a minute examination will be made regarding the admissibilty in relation to the appropriateness of the usual mode of representation. Communications may be mathematically or philosophically and psychologically inclined, and historical studies are desired but not demanded.

Papers competing for this prize must be written in a modern language, and will be received by the Dekan of the Philosophical Faculty up to August 31, 1900. A motto should be written on the title-page of the work and on the outside of a sealed letter which must accompany it, containing the name, profession, and address of the sender. In no other way can the name of the author be communicated. It is further requested that the address of the sender should be also written on the title-page, in case the prize should not be awarded to it. The first prize amounts to 3400 marks, and the second to 680 marks.

The prizes will be awarded on March 11, 1901, at a meeting of the Philosophical Faculty in Göttingen. The communications to which prizes are awarded remain the property of the authors. The prize problems, for which the competitive papers must be sent in by August 31, 1898, and August 31, 1899, will be found given in the *Königlichen Gesellschaft der Wissenschaften Geschäftl. Mittheilungen*, 1896, S. 69, 1897, Heft. 1, S. 26.

NOTES.

THE Committee of Administration of the Paris International Exhibition of 1900 have adopted a scheme of arrangement of the exhibits according to the nature of the objects, instead of by nationalities. The exhibits will be arranged in groups, containing between them 120 classes. The subjects of the groups are: education and teaching, literature, science and art, instruments and processes; machinery and mechanical processes; civil engineering, construction, means of transport; agriculture, horticulture, arboriculture, forestry, sport, &c.; alimentary products; mines and metallurgy; decoration and furniture of public and private buildings; yarns, fabrics, clothing; industrial chemistry; miscellaneous industries; social economy, hygiene, public charities; colonisation; naval and military.

PRINCE ALBERT OF MONACO gave an account of his investigations in the Atlantic at the meeting of the Royal Geographical Society on Monday. From 1885 to 1889 Prince Albert made some long cruises in the *Hirondelle*, a little sailing schooner of 200 tons, which took him as far as the American coasts, and he explored depths as great as 1600 fathoms without help of any power greater than the arms of his fourteen sailors. The *Hirondelle* being shattered by storms, he built a stronger steam-vessel, the *Princess Alice*, 560 tons, to carry on the same research with better appliances. The work of this second period opened up to him fields of labour altogether beyond his reach without the aid of a still larger and more powerful vessel, so he commissioned Messrs. Laird, of Liverpool, to build him another *Princess Alice*, which is expected to set out on her first voyage in a few weeks. After giving the results of the more important of his observations with respect to currents, depth and pressure, temperature, salinity, light, and ocean deposits, Prince Albert proceeded to treat of the organic life inhabiting the waters of the open ocean, and described the principal apparatus employed by him for biological investigations.

MR. W. H. PREECE, C.B., F.R.S., was elected president of the Institution of Civil Engineers at the annual general meeting held on Tuesday.

MR. J. J. H. TEALL, F.R.S., has been elected into the Athenæum Club, under the rule which empowers the annual election of nine persons "of distinguished eminence in science, literature, the arts, or for public services."

THE Royal Photographic Society's International Exhibition was opened by the Prince of Wales at the Crystal Palace on Monday. A large number of interesting photographs, many of them illustrating scientific applications of photography, are included among the exhibits.

THE annual reception and exhibit of recent progress in science of the New York Academy of Sciences was held on April 13 and 14. Though not so large as former exhibitions, it was characterised by the president of the Academy, Prof. Henry F. Osborn, as the most complete and diversified of any, representing nearly all the leading educational institutions of the United States, and containing exhibits from very many of the States and many foreign countries. Addresses were delivered by the recording secretary, Prof. Richard E. Dodge, President Osborn, Prof. George E. Hale, of the Yerkes Observatory, on "The Function of Large Telescopes," Mr. Morris K. Jesup, president of the Museum, and Mr. Charles E. Tripler, who exhibited liquid air obtained by his apparatus. Among the objects included in the exhibition, the fine array of photographs of stars and star spectra was noticeable. In the department of photography some excellent colour photographs were shown, including a demonstration of colour photographs by the Joly process, shown by the Joly-Zambra Company.—In electricity, apparatus was exhibited for the transmission of signals without intervening wires. The feature of the palæontological exhibition was the caudal vertebræ and limb bones of the gigantic Dinosaur Camarasaurus, the largest land animal that ever lived. The bones exhibited were the largest yet found, and were recently exhumed. Several new kinds of apparatus were shown in the physics section. Specially important, in an economic sense, was the stremmatograph, an instrument to measure compression and extension of rails of a railroad during the passing of trains, exhibited by Mr. P. H. Dudley.—The geological exhibit contained many interesting features; including specimens brought back from the excursion of geologists after the geological congress in Russia last year, some of the latest maps of the U.S. Geological Survey, a model of the Franklin furnace zinc ore bed from New Jersey, gold-bearing conglomerates from the so-called "banket" reefs near Johannesburg, South Africa. Specimens of compressed marble were shown, which had been subjected to the pressure of 100 tons to the square inch without rupture or destruction of cohesion.—Mr. H. E. Crampton, jun., exhibited some fine specimens of fused or compound pupæ and compound adult moths. His recent products include some very perfect tandem moths with two full sets of wings; also moths which have the head of one grafted upon the back of another. The exhibition of ethnology included results of the Jesup North Pacific exploring expedition and collections of the Huichol Indians of Mexico. The exhibits generally were designed to show the progress made during the year. The department of philology, however, having only been added to the exhibition this year, took a wider range.

IT is announced in *Science* that at the recent annual meeting of the New York Academy of Sciences the following elections as Honorary and Corresponding Members were made: *Honorary*—Prof. Arthur Auwers, Astronomer, Berlin; Prof. W. K. Brooks, Biologist, Baltimore; Prof. David Gill, Astronomer, Cape Town; Dr. George W. Hill, Mathematician, Nyack; Prof. E. Ray Lankester, Zoologist, Oxford; Dr. Fridjof Nansen, Explorer, Kristiania; Prof. Albrecht Penck, Geographer, Vienna; Prof. Wilhelm Pfeffer, Botanist, Leipzic; Prof. Hans Reusch, Geologist, Kristiania; Prof. Rudolph Virchow, Biologist, Berlin; Prof. Karl von Zittel, Palæontologist, Munich. *Corresponding*—Prof. F. D. Adams, Geologist, Montreal; Prof. I. B. Balfour, Botanist, Edinburgh; Prof. George Baur, Palæontologist, Chicago; Prof. William Carruthers, Botanist, London; Prof. T. C. Chamberlin, Geologist, Chicago; Prof. Wm. M. Davis, Geographer, Cambridge; Prof. Adrien Franchet, Botanist, Paris; Prof. George E. Hale, Astronomer, Chicago; Prof. J. P. Iddings, Geologist, Chicago; Prof. Charles S. Minot, Biologist, Boston; Prof. George Murray, Botanist, London; Prof. William B. Scott, Geologist, Princeton; Mr. Charles D. Walcott, Geologist, Washington; Prof. Charles O. Whitman, Biologist, Chicago; Prof. Henry S. Williams, Palæontologist, New Haven.

A VERY elaborate series of experiments on the tractive resistance of express passenger trains running on the Northern of France Railway shows (says *Engineering*) that the engine and tender resistances amount to about half the total. The trains on which the experiments were made weighed, on the average, 160 tons, exclusive of the engine and tender, which weighed 85 tons more.

THE Royal Agricultural Society offers, in connection with the meeting at Maidstone next year, a prize of 50*l.* for the best machinery for washing hops with liquid insecticides, the machine in question being worked by horse or mechanical power. Full particulars of the regulations governing the proposed competitive trials can be obtained on application to the Secretary, 13 Hanover Square, London, W.

PROF. JAMES E. KEELER, of the Allegheny Observatory, has definitely accepted the post of director of the Lick Observatory, and will go to Mount Hamilton next month. It will be remembered that he offered to remain at the Allegheny Observatory if 200,000 dollars could be collected to erect and endow a new observatory. The subscriptions did not reach this amount in the two weeks allowed, but 150,000 dollars was subscribed, so that a new observatory will be built.

A NEW coherer for use in connection with telegraphy without intervening wires has been invented by Dr. H. Rupp, of Stuttgart. Instead of using an electro-magnetic tapper to tap the coherer tube, and so loosen the iron filings in it, Dr. Rupp has devised a simple contrivance for making the coherer rotate round the axis of the leading-in wires. It is stated that the Morse signals obtained with this rotating coherer are much more distinct than those given by the tapping arrangement.

DR. HENRY MARSHALL, a distinguished member of the medical profession, died on Sunday at Clifton, Bristol. Dr. Marshall received his medical education at Edinburgh; and in 1854, was dresser and afterwards assistant under Lord Lister, whom he succeeded as house surgeon. Whilst in Edinburgh he held the presidency of the Royal Medical Society there. When the British Medical Association met at Bristol in 1863 Dr. Marshall acted as secretary, and he was president of the Bristol branch when in 1877 the Association met at Bath.

WE have just received, with regret, the announcement of the death, on March 24, of Mr. Alfred U. Allen, of Bath, at the age of sixty-four. Mr. Allen's name will be long remembered by microscopists as the secretary of the Postal Microscopical Society, which came into existence about twenty-five years ago largely through his exertions. It is only a few months since we announced that Mr. Allen had found it necessary to discontinue the *Journal of Microscopy and Natural Science*, which he edited since 1882. In addition to this, Mr. Allen issued a monthly journal, under the title of *The Scientific Enquirer*, during the years 1886–88.

COL. SIR VIVIAN D. MAJENDIE, K.C.B., the chief inspector of explosives to the Home Office, died suddenly on Sunday. He was the author of the Official Guide-book to the Explosives Act of 1875, and several other professional works. In his official capacity he was responsible not only for the periodical inspection of the various gunpowder and kindred manufactories scattered throughout the country, and for the investigation of the circumstances attending the accidents that occur in them from time to time, but also had to examine very many of the bombs and infernal machines that fell into the hands of the police, or were left for felonious purposes in public places. He was also concerned with drawing up regulations for the storage of inflammable liquids such as petroleum, and it is not very long since he returned from a tour in America undertaken to study the methods of storage and transport in operation there.

ZOOLOGY has lost an able student and a promising investigator by the death, at the age of twenty-six years, of Mr. B. B. Griffin, announced in *Science*. Mr. Griffin took part in the zoological expeditions to the north-west coast of America, sent out by Columbia University in 1896 and 1897. He was the author, wholly or in part, of several papers relating to the fauna of that region, one of which, dealing with the nemertines of Puget Sound and describing a number of species new to science, had been sent to press immediately before his last illness. His principal work lay, however, in the field of cellular biology, and a brief but important paper by him on the fertilisation of the egg in *Thalassema*, published in the *Transactions* of the New York Academy of Sciences for 1895–6, had attracted considerable attention, both in the United States and elsewhere. A more extended paper along the same lines, bringing forward new and important evidence on the nature of fertilisation, the history of the centrosome, the phenomena of chromatin-reduction and other vexed problems of cytology, was practically ready for the printer at the time of his death.

WE regret to record the death of the distinguished geologist M. Jules Marcou. He was born at Salins in the Department of Jura in France, in 1824. In 1848 he joined Agassiz at Boston, in the United States, and spent two years in studying the geology of various portions of North America. In 1853 he published a Geological Map of the United States, and the British Provinces of North America. For a period of about twelve years M. Marcou appears to have spent much of his time alternately in Europe and America. In 1855 he became professor of geology and palæontology at the Polytechnic School of Zürich, but relinquished this office on his return to the United States in 1860. In 1861 he published his well-known Geological Map of the World, of which a second edition was issued in 1875. In addition to his works on the geology of North America, he published many papers on the European secondary rocks, and was specially interested in the Jura-Cretaceous formations. Some of his articles were of a controversial nature. In 1879 he was elected a Foreign Member of the Geological Society of London. He died on April 18, at Cambridge, Massachusetts, aged seventy-four.

IT is with much regret that we record the death of Dr. John Shearson Hyland, F.G.S., at the early age of thirty-two. The second son of Captain P. Hyland, of Great Crosby, he was educated at the Merchant Taylors' School, at University College, Liverpool, and subsequently at Leipzig. At the University of Leipzig he studied mineralogy and petrology under Dr. Zirkel, and took the degree of Ph.D., his thesis being entitled "Ueber die Gesteine des Kilimandscharo und dessen Umgebung," and published in 1888. In the same year he joined the staff of the Geological Survey, and was for three years occupied in the Irish branch in investigations on the eruptive rocks of the country. During this period he published several papers on petrological subjects, and gave great promise of a brilliant career. Being of an active, enterprising nature, he relinquished the work of the microscope, and throwing up his post on the Geological Survey, took to the more practical work of reporting on mineral resources in the United States, subsequently in British Central Africa, and finally on the treacherous west coast of Africa, where he died at Elmina on April 19.

THE death is announced of Dr. J. G. N. Dragendorff, for many years director of the Pharmaceutical Institute at Dorpat, in Russia, which, while he was there, had the highest reputation as a pharmaceutical training college and school of research. From the *Chemist and Druggist* we learn that Dr. Dragendorff was born in Rostock in 1836. After qualifying as an apotheker, he studied chemistry in the Heidelberg University, which he left in 1860 to become assistant to Prof. F. Schultze, in the chemical laboratories of the Rostock University. In the same year he graduated as Ph.D., his thesis being on the action of phosphorus upon some carbonates and borates. In 1862 he went to St. Petersburg to take charge of the *Pharmaceutischen Zeitschrift für Russland*, as editor, and of the laboratories of the Pharmaceutical Society there. While acting in that capacity his reputation grew, and his appointment as Professor of Pharmacy and Director of the Pharmaceutical Institute at Dorpat in 1864 was the beginning of thirty years' work which made the Dorpat Institute famous all over the world, for Dragendorff's skill as a teacher and discoverer of talent brought students to him from all quarters. He retired to his native town in 1894, and devoted his leisure to a monumental work on medicinal plants, of which at least one part has been

published. He was best known to English pharmacists through his "Plant Analysis," a translation of which, by his former pupil, Henry G. Greenish, was published in 1883. His work on alkaloids was, however, that by which he is most entitled to fame. The mydriatic alkaloids were his special field, and his syntheses of conine and atropine are amongst the most brilliant achievements of modern chemistry. In 1885 the Pharmaceutical Society of Great Britain conferred the third Hanbury medal upon him.

THE Kew Observatory Committee have issued their Report for the year 1897. During that period the magnetic curves have been free from any very large fluctuations; the mean westerly Declination for the year was 17° 6′, and the mean Inclination, 67° 20′. The meteorological observations conducted for the Meteorological Council call for no special remarks; the electrograph has been in nearly constant operation since January 19. Several hours' record were lost owing to the trace being off the sheet; Dr. Chree states that it is difficult to see how such loss can be avoided without either duplicating part of the apparatus, or by risking possible loss of negative trace by shifting the position of the zero line on the sheet. Sketches of sun-spots were made on 165 days; it has been decided to discontinue the eye observations, owing to the elaborate photographic work now done elsewhere. Among the various experiments and researches in connection with the several departments we observe that attention has been given to the comparison of platinum and mercury thermometers at high temperatures, in view of repeated requests for direct high temperature verifications. Experiments are also being made as to the thermometric properties of different kinds of glass, the results of which will be eventually published. The usefulness of the institution is shown by the continual increase in the number of instruments submitted for verification; the increase during the year in question amounted to nearly three thousand. In addition a large number of watches and marine chronometers were received for trial.

A NUMBER of investigations have been made on the connection of various terrestrial phenomena with the period of rotation of the sun, but the results obtained have not been definite enough to establish the reality of a twenty-six-day period of meteorological phenomena. In connection with this question, Prof. Arthur Schuster subjects the methods of finding hidden periodicities—small periodic variations hidden behind irregular fluctuations—to vigorous analysis in *Terrestrial Magnetism* (March), with the object of introducing a little more scientific precision into the treatment of problems involving hidden periodicities, and of applying the theory of probability in such a way as to assign a definite number for the probability that the effects found by means of the usual methods are real, and not due to accidental circumstances. The methods described show the lines which investigations on the periodicity of phenomena should follow, and point to several interesting subjects to which they may profitably be applied. As to results already published, Prof. Schuster concludes:—"The general result of a critical examination of the published investigations on the twenty-six-day period leads me to think that, although the magnetic elements and the occurrence of thunderstorms seem to be affected by a period of twenty-six days and of its first multiple, the subject requires a good deal of further study before we can be sure as to the exact nature of the period. Even though it may be considered as proved, it must not be necessarily assumed that it is due to solar action. If it was a question merely of magnetic disturbances, there does not seem to be any great improbability, however, that some periodicity may be connected with the sun's rotation about its axis, especially at times of great sun-spot activity."

IN a short note in the *Comptes rendus* (No. 15, April 1898), M. Thiébaut gives us the result of his investigations on the frequency of the extra large tides which occur at the March equinox. He has used the number previously published in the *Connaissance de Temps* since the beginning of the century, and has shown that the relative magnitude of the coefficients of the tides at the syzygies vary notably from one year to another, but that the rule given below is subject to some exceptions. From the theoretical point of view this law of the variation of the coefficients assigns to the return of this great tide a period of about nine years if only one equinox is considered, or four and a half years if one indifferently takes account of the spring or autumn equinoxes. The principal cause of these variations he attributes to the movement of the moon's perigee, which completes one revolution in about 8 years and 310 days. Taking into account all the circumstances of the phenomenon he discovered a remarkable period of 412 days, at the completion of which the sun returns to the lunar perigee. This period he calls the "année périgéenne"; and it does not differ very much from two other interesting periods, one of 413·4 days, which corresponds to 14 lunar months (synodic), the other of 413·3 days, or 15 anomalistic months.

THE theory which attributes volcanic eruptions to disturbances produced beneath the earth's crust by luni-solar tide-generating forces would receive striking confirmation by the establishment of a connection between the periods of greatest volcanic activity and the phases of the moon which give rise to spring tides. Prof. Eugenio Semmola, writing in the *Atti del R. Istituto d'Incoraggiamento* (Naples), has compared the periods of maximum and minimum activity of Vesuvius with the phases of the moon during the two years from July 1895 to July 1897. The conclusions drawn from these observations are entirely of a negative character; the number of days of maximum and minimum activity being largely in excess of the number of lunations in the same period, and the fresh flows of lava being distributed fairly evenly between the moon's four quarters. A comparison of the more violent eruptions of Vesuvius from the year 1800 to the present time shows that in five of these the nearest phase of the moon was the new or full moon, and in the remaining five the nearest phase was the first or last quarter. It thus appears that no relation exists between the activity of Vesuvius and the phases of the moon.

THE *Journal de Physique* for April contains the continuation of an important paper, by M. A. Leduc, on the densities and molecular volumes of gases. M. Leduc has established, under the name of "law of molecular volumes," a limiting law, which he proposes as a substitute for the principle of Avogadro and Ampère. This law he applies to the calculation of the densities and coefficients of expansion of a number of gases, and every experimental determination appears to agree with the predicted results.

IN the same journal, M. J. Macé de Lépinay gives a proof that the fringes of caustics and the supernumerary arcs of rainbows can be regarded as true interference-fringes.—M. P. Morin considers the influence of the length of magnets on their mean intensity of magnetisation. In needles of the same material and cross-section magnetised to the point of saturation, the intensity of magnetisation and the magnetic density at the two ends are independent of the length of the needle, and the same is the case for all sections taken at equal distances from the extremities.

NEW magazines devoted to discussion of the Röntgen rays appear to be springing up in every direction. From St. Louis we have received the *American X-Ray Journal*, which is stated on the cover to be "a monthly devoted to the practical application

of the new science and to the physical improvement of man." It is illustrated by very fair radiographs of fractures and dislocations, and a somewhat striking "skiagram" of a loaded Lebel rifle.

WE have received the second part of the *Annales d'Électrobiologie, d'Électrothérapie et d'Électrodiagnostic*. This new bimonthly journal deals with the applications of electricity to medical purposes, including the uses of Röntgen rays. In addition to original papers, a full bibliography of current literature is given. M. Félix Alcan, of Paris, is the publisher.

WRITING in the *Rendiconti del R. Istituto Lombardo*, xxxi., Signor Luigi de Marchi criticises the views advanced by Arrhenius on the causes of the variations of climate considered specially with reference to the influence of carbonic acid on the temperature of the ground (see *Philosophical Magazine*, 1896, p. 237). He considers that Arrhenius is in error (1) in treating as negligible the variations in the solar radiation produced by even considerable increases in the carbonic acid and watery vapour of the atmosphere; (2) in attributing a definite physical meaning to the coefficient which represents the coefficient of emission of a fictitious stratum whose radiation is equivalent to that of the atmosphere; and (3) in assuming that the same coefficient also represents the coefficient of absorption of the stratum in question for terrestrial radiations.

THE Astronomical and Physical Society of Toronto seems to be in an ever flourishing condition, judging from the *Transactions* which appear from time to time. The latest volume, for the year 1897, which includes the eighth annual report, displays the Society's activity by the numerous and varied papers which were communicated during the past twelve months. Among these papers may be mentioned an historical sketch of the Greenwich *Nautical Almanac*, periodicity of magnetic elements, the November meteors of 1832 and 1833, the variable star Algol, &c. Mr. G. E. Lumsden made a short communication on the best method of making the work of the Society valuable, and his suggestions are such that any other society might learn a good lesson by following them. We hope to see this scheme carried out successfully, as its lines, corresponding to those of the subdivision of labour of the British Astronomical Association on this side of the Atlantic, are undoubtedly sound.

SEVERAL interesting reminiscences of the Edinburgh Medical School in the 'fifties and 'sixties are given in an article in *Chambers's Journal* for April. The teachers in the University at that time—Syme, Simpson, Goodsir, Christison, Hughes-Bennett, Playfair, Douglas Maclagan, Laycock, Turner, Allmann, Balfour, Henderson and the rest—all take prominent places in the history of the science and practice of medicine. Referring to Sir James Simpson and the use of chloroform, the writer remarks that deaths under this anæsthetic were almost unknown in his days. He says: "We hardly ever used a stethoscope to examine the heart, or felt the pulse, and the patients did not die. . . . Both Simpson and Syme taught that chloroform should be inhaled from being sprinkled on a towel, the two golden rules being to see that the vapour was properly diluted by the surrounding air, and to watch the breathing, holding the towel some inches from the face. It may be a coincidence merely; but if so it is remarkably strange that, while the chloroform has not changed, while the constitutions of the patients have not changed, where the use of an inhaler is the rule, there are frequent deaths from chloroform; whilst in Scotland and Ireland, where the use of an inhaler is the exception, deaths are proportionately rare."

SOME interesting investigations on the behaviour of micro-organisms in the presence of compressed gases have been published by G. Malfitano in the *Bollettino della Società medico-chirurgica di Pavia*. The more importance attaches to these researches, inasmuch as compressed carbonic acid gas has been lately regarded by some authorities as endowed with trustworthy antiseptic or sterilising properties. Malfitano's investigations do not, however, support this view. A large number of experiments were made with pure cultures of various bacteria in a dry condition, exposed for periods of time varying from 20 to 64 hours to a maximum pressure of 55 atmospheres. Whilst some bacteria were destroyed, amongst which we note *B. coli communis*, *B. anthracis*, *saccharomyces cerevisiæ*, the hyphomycetes, and *B. subtilis*, invariably withstood this influence. In other experiments we find again a large number of bacterial varieties exposed to pressures varying from 60–25 atmospheres, with the result that whilst typhoid and cholera bacilli, the *B. prodigiosus*, staphylococcus pyogenes aureus, and citreus and other well-known varieties succumbed more or less rapidly, *B. subtilis*, *B. mesentericus*, Tyrothrix, and *B. œdematis* invariably survived. It should be mentioned that no permanent biological modification in the bacteria employed was observed to result from exposure to compressed carbonic acid gas. Judging by experiments carried out to ascertain the relative effect of length of exposure to, and degree of pressure of this gas upon bacteria, it would appear that the latter factor was of more importance than the former. Endeavours were made to, if possible, increase the bactericidal potency of the gas, by submitting bacteria to the *interrupted* action of the gas. For this purpose subtilis bacilli, containing their well-known hardy spore forms, were employed. These bacilli were exposed for 20 hours to the gas at intervals of 24 hours, this being repeated four times, but no different result followed. It will be remembered that alternately freezing and thawing bacteria tends to increase the sensitiveness of, at any rate, some bacteria to extreme cold. The author tried, finally, the effect of liquefied carbonic acid gas upon the vitality of the spores of *B. subtilis*; but from this test, also, they emerged triumphant, suffering no damage at all.

THE current number of the *Journal of the Sanitary Institute* contains papers on a variety of subjects; amongst them we notice one on poisoning by canned foods, by Dr. F. Brown. The writer has collected all the reports which have appeared in medical journals since the year 1879 of cases of poisoning from tinned foods. As regards fish and meat thus preserved, the poisonous effect is probably due to the presence of ptomaines, and the only way of preventing this dangerous deterioration is to take all possible precautions that the materials used are of the very best quality, and that the canning process is carried on under the strictest hygienic conditions. Canned fruits do not appear to have been responsible for any fatal cases of poisoning, but salts of tin and zinc are frequently present in such materials. In some instances, especially in cans containing pears and apricots, lead in quantities sufficient to give rise to lead-poisoning was found, whilst in other canned fruits the apricots had acquired a metallic taste from the amount of metal present. As all canned foods are better for being used soon after canning, a good plan would be to state on each tin the date of its canning, so that the public may have some guide as to the quality of the article they are purchasing.—A paper on the contamination of water supplies by encampments of hop-pickers, gipsies, &c., is contributed by Miss Chreiman. Although some allowance must be made for the unfortunately exaggerated style of the writer, there can be no doubt that she has done good service in once more bringing before the general public the highly unsatisfactory conditions under which hop-picking is now carried on. Possibly the Maidstone typhoid epidemic of last autumn may succeed in rousing local authorities to take effective measures to provide for, and officially organise, this periodic invasion of country districts. Surely, for example, the sleeping

on "beds of short straw, beneath which was a mattress of cattle manure two spades deep," ought to be an impossibility at the close of the nineteenth century.

A PRELIMINARY report, by Mr. Milton Whitney, upon the soils of the principal tobacco districts in the United States has just been published by the United States Department of Agriculture. The tobacco-plant readily adapts itself to a great range of climatic conditions, and will grow on nearly all kinds of soil, but the flavour and quality of the leaf are greatly influenced by the conditions of the climate and soil. So far as climate is concerned, Mr. Whitney remarks that experience is the only safe test as to the class of tobacco which can be produced under given climatic conditions. Ordinary meteorological records appear to be of little value in determining this point; for the tobacco-plant is more sensitive to meteorological influences than the instruments. Even in such a famous tobacco region as Cuba, tobacco of good quality cannot be grown in the immediate vicinity of the ocean, or in certain parts of the island, even on what would otherwise be considered good tobacco lands. This has been the experience also in Sumatra and in the United States, but the influences are too subtle to be detected by ordinary meteorological instruments. Little, therefore, can be said at the present time in regard to the suitable climatic condition for tobacco of any particular type or quality. Under given climatic conditions, the class and type of tobacco depend upon the character of the soil, especially on the physical character of the soil, upon which it is grown. The texture or coarseness of the soil grains, and the water content, which is largely dependent upon it, appears to determine and control the distribution of the different widely distinct types of tobacco. This conclusion is borne out by Mr. Whitney's mechanical analyses of tobacco soils, consisting of separating the particles of soils into grades of different sizes. The results show a very marked difference in the texture and physical properties of the soils adapted to the different classes, types, and grades of tobacco, and give a basis for the classification of tobacco soils.

DR. SUPAN has a short article on antarctic exploration in *Petermann's Mittheilungen*. The German and English proposals are described, and Brückner's calculations of climatic periods quoted to show that the present is an exceptionally favourable time for penetrating southward. The period of Ross's voyages was probably much colder than the average.

DR. ERICH VON DRYGALSKI publishes in *Petermann's Mittheilungen* a paper on ice movements, their physical causes, and their geographical effects. The paper is in effect an abstract of results of the work of the Greenland expedition of the Berlin *Gesellschaft für Erdkünde*, published in full as a separate volume in the course of last year.

THE April issue of the *National Geographical Magazine* is a Klondike number, and contains several trustworthy articles on the conditions, resources and future of Alaska and the Yukon gold-fields. A map of the gold- and coal-fields of Alaska, and showing also the principal steamer routes and trails, on a scale of about fifty-seven miles to one inch, accompanies the papers in the magazine.

NOS. 5 and 6 of vol. xxxii. of the *Zeitschrift der Gesellschaft für Erdkünde zu Berlin* contain papers by Herr E. de Martonne on the hydrography of the basin of the Upper Nile, by Dr. A. Galle on Dr. Philippson's measurements of heights on the Greek islands of the Ægean, on a new map of the eastern part of New Britain by Freiherr von Schleinitz, and on journeys in the Upper Amazon region by Dr. A. Rimbach. Herr E. de Martonne's paper is a review of the present state of knowledge regarding the Upper Nile, with a new orographical map and a sketch of seasonal distribution of rainfall.

AMONG the papers in the current number (April) of the *Journal* of the Royal Horticultural Society are several of scientific interest, in addition to papers on progress in the methods and results of cultivation. Mr. C. C. Hurst describes some curiosities of orchid breeding, and his experiments and observations on hybrids are of distinct value. Prof. F. W. Oliver has a paper on the depth in the soil at which plants occur, and Prof. Geo. Henslow one on chrysanthemum sports.

AMONG reprints of important papers from the *Botanical Gazette* we have received:—Winter characters of certain sporangia, by Charles J. Chamberlain; contributions to the life-history of *Ranunculus*, by Prof. Coulter; and a general review of the principal results of Swedish research into grain-rust, by Prof. J. Eriksson. The Swedish professor distinguishes eight distinct forms of *Puccinia* which produce rust; these being again arranged under a number of secondary forms, dependent on the host-plant, most of the primary forms being parasitic on several different species.

THE views with regard to the origin of vertebrates, put forward by Dr. W. H. Gaskell, F.R.S., in his presidential address to the physiological section of the British Association, at the Liverpool meeting in 1896, are to be stated more fully in the *Journal of Anatomy and Physiology*. The April number of the *Journal* contains the first of a series of papers in which Dr. Gaskell will fill in the details of evidence which were necessarily omitted from his address.

A COPY of Mr. Joseph Baxendell's report on the results of observations made at the Southport Corporation Meteorological Observatory during 1897 has been received. A noteworthy feature of the report is a comparative table showing the mean annual meteorological statistics for every health resort in the United Kingdom known to possess a meteorological station. The systematic work done in the meteorological department of the borough of Southport should encourage accurate health resort climatology in general, and municipal meteorology in particular.

INCLUDED in the "Bergens Museums Aarbog" for 1897 is Prof. R. Collett's interesting paper on Beavers in Norway, with twelve plates reproduced from photographs of beaver lodges and dams. The subjects of other papers are:—Generalisation of some algebraic equations which present themselves in the theory of elliptic functions; a Sowerby Whale (*Mesoplodon bidens*, Sow.), stranded on the west side of Karmö Island; histological studies of the structure of the eyes of certain marine annelids; a generalisation of the Lamé equation; the Lepidoptera of North Bergen county; physical conditions and plankton of Puddle fiord.

IN a memoir which appears in the *Proceedings* of the U.S. National Museum (vol. xx. pp. 1–421, 1897), Mr. S. H. Scudder describes in detail and discusses the classification of a group of grasshoppers which forms the prevailing type of orthopteran life throughout North America—the short-horned grasshopper commonly seen in the United States, its best-known representative to the world at large being the destructive migratory Rocky Mountain Locust. The title of Mr. Scudder's paper is "Revision of the Orthopteran Group Melanopli (Acridiidæ), with special reference to North American forms."

THE natural history societies of our public schools deserve encouragement, for they create interest in natural things and phenomena, and lead inquiring minds to make observations for themselves. The reports of three such societies, namely those of Rugby, Wellington, and Cheltenham, showing the results of observations, and containing abstracts of lectures, have been received, and each of them is a creditable production. Among

the papers which call for special attention is an essay upon the birds of the Oxford district, by Mr. F. Sidgwick, in the Rugby Society's report; and one on birds and birds-nesting, by Mr. C. Montford, in the Cheltenham Society's report.

ARCHÆOLOGISTS will be interested in a paper on "Dwellings of the Saga-time in Iceland, Greenland, and Vineland," by Cornelia Horsford, which appears in the *National Geographic Magazine* (March). The Saga-time began with the colonisation of Iceland in 875, and lasted for about 150 years, but little definite knowledge exists as to the forms of the dwellings in those days. The paper is illustrated by plans of Norse ruins (so far as they are known) in Iceland and Greenland, and of a supposed Norse ruin in Massachusetts. It will enable a comparison to be made between the different dwellings of the Northmen and those of the native tribes of North America, from the magnificent ruins of Copan to the long, narrow houses of the Iroquois.

PROF. WILLIAM SOMERVILLE'S sixth annual report on experiments with crop and stock in the counties of Cumberland, Durham and Northumberland, provides an excellent example of useful technical education assisted by County Councils. In the work of agricultural demonstration described in the pages of the report, the Durham College of Science was associated with the Councils of the counties above referred to, and the information given will be distinctly valuable to the agriculturists of these counties. Of especial importance are the results of rotation experiments which have been carried on for four years on three Northumberland farms. The results obtained at these stations are tabulated, but the detailed discussion of the rotation experiments has not yet been completed.

THE fourth number of "The Psychological Index"—a bibliography of the literature of psychology and cognate subjects for 1897, compiled by L. Farrand and Howard C. Warren—is a most useful publication for psychologists. The papers are well classified, and there is an index of authors; so it is easy to find what contributions have been made to the various branches of the science, and what the various investigators have done. There are 2465 titles in the Index, thus indicating considerable activity in psychological science. The Index is issued in connection with the *Psychological Review*, which is published bi-monthly by the Macmillan Company.

A *Bulletin* (No. 13, new series), containing a compilation, by Dr. L. O. Howard, of recent laws and regulations against injurious insects, and especially the San José scale, has been issued by the U.S. Department of Agriculture. The information given will be of interest to persons engaged in trade with living plants, and to horticultural and agricultural societies and others wishing to propose legislation of the kind described. Another *Bulletin* (No. 12), just issued by the U.S. Department of Agriculture, gives an account of the spread of the San José scale in the United States during the last two years, and of the work which has been done by economic entomologists in the effort to subdue it.

THE latest phases of the controversy concerning the place where John Cabot first landed in North America four hundred years ago, are presented in a paper by Dr. S. E. Dawson, on "The Voyages of the Cabots," published in the *Transactions* of the Royal Society of Canada for 1897. Dr. Dawson concludes "that there is no physical or geographical reason *à priori* why Cape Breton may not have been Cabot's landfall, and that the voyage was intended to be upon a westerly course. It will also appear that all the conditions existing upon the North Atlantic tend to make a westerly course swerve to the south, and that there is, therefore, a strong preponderance of probability in favour of a landfall at Cape Breton." Positive evidence of contemporary documents is shown to point to the same conclusion.

MESSRS. MASSON AND CO., Paris, will shortly publish the following works of science:—"L'Anatomie comparée des animaux basée sur l'embryologie," by Prof. Louis Roule; "Précis de Botanique médicale," by Prof. L. Trabut; "Eléments de Botanique," by Prof. Ph. van Tieghem.

MR. T. R. DALLMEYER has just published a useful little book entitled "A Simple Guide to the Choice of a Photographic Lens." This book seems to be exactly suited to the requirements of a whole host of photographers, especially amateurs who prefer to have their information retailed concisely and simply by one who knows. A great feature of these thirty pages is the appeal to diagrams which illustrate more clearly than words many fundamental facts regarding lenses and their behaviour. Four excellent platino-bromide reproductions are inserted, to illustrate the capabilities of the author's new universal stigmatic lens, Series ii. F/6, which does the work of practically four ordinary lenses.

THE firm of Gustav Fischer, Jena, announces for early publication the following new works and new editions:—"Ueber Herzbewegung und Herzstoss," by Dr. Ludwig Braun. This volume will contain the results of an experimental study of movements of the heart, analysed by means of a kinematograph.—"Die Bakteriologie in der Milchwirtschaft," by Dr. E. von Freudenreich.—The second part of Dr. Oscar Hertwig's work on "Die Zelle und die Gewebe," dealing with the general anatomy and physiological properties of the tissues.—"Beiträge zur Klinik der Rückenmarks-und Wirbeltumoren," by Dr. H. Schlesinger.—The first section of "Mitteilungen aus der Augenklinik," by Dr. J. Widmark.—The fourth enlarged edition of Dr. Robert Wiedersheim's "Grundriss der vergleichenden Anatomie der Wirbeltiere."

THE Chemical Publishing Company, Easton, Pennsylvania, has published a second, thoroughly revised edition of "Laboratory Experiments on the Class Reactions and Identification of Organic Substances," by Dr. A. A. Noyes and S. P. Mulliken. A sixth edition of Mr. P. McConnell's serviceable "Notebook of Agricultural Facts and Figures for Farmers and Farm Students" has been published by Messrs. Crosby Lockwood and Co.—The present state of knowledge of Röntgen radiation and its practical applications is well stated in the second edition of "Practical Radiography" by A. W. Isenthal and H. Snowden Ward, published by Messrs. Dawbarn and Ward. Many of the illustrations in the book are very fine.—A revised and enlarged edition (the sixth) of Messrs. Marion and Co.'s well-known "Practical Guide to Photography" has just been issued.

THE additions to the Zoological Society's Gardens during the past week include four Silver Pheasants (*Euplocamus nycthemerus*) from China, presented by Mr. H. J. Veitch; a Common Barn Owl (*Strix flammea*), captured at sea, presented by Captain George Innes; a Black-winged Peafowl (*Pavo nigripennis*, ♂) from Cochin China, presented by Mr. Richard H. J. Gurney; four Undulated Grass Parrakeets (*Melopsittacus undulatus*) from Australia, presented by Mr. Aitchinson; a Black-bellied Sand Grouse (*Pterocles arenarius*) from Asia, a Pin-tailed Sand Grouse (*Pterocles alchata*), South European, a Rosy Bullfinch (*Erythrospiza githaginea*) from Algeria, presented by Mr. E. G. B. Meade-Waldo; two Common Bluebirds (*Sialia wilsoni*) from North America, two Yellow-bellied Liothrix (*Liothrix luteus*) from China, an Amaduvade Finch (*Estrelda amandava*) from India, a Red-bellied Waxbill (*Estrelda rubriventris*), a Crimson-eared Waxbill (*Estrelda phœnicotis*) from West Africa, presented by Miss Edith M. Kemp Welch; four

Amaduvade Finches (*Estrelda amandava*), a Green Waxbill (*Estrelda formosa*), two Black-headed Finches (*Munia malacca*), two Chestnut-bellied Finches (*Munia rubro-nigra*), three Indian Silver-bills (*Munia malabarica*) from India, a Common Waxbill (*Estrelda cinerea*), three Orange-cheeked Waxbills (*Estrelda melpoda*), two Red-bellied Waxbills (*Estrelda rubriventris*), a Paradise Whydah Bird (*Vidua paradisea*), a Grenadier Weaver Bird (*Euplectes oryx*) from West Africa, three Banded Grass Finches (*Poëphila cincta*) from Queensland, a Bar-breasted Finch (*Munia nisoria*) from Java, a Maja Finch (*Munia maja*) from Malacca, a Chestnut-eared Finch (*Amadina castanotis*) from Australia, presented by Miss Petrocochino; two Black Rats (*Mus rattus*) from the Channel Islands, presented by Mr. J. Ernest Ardron; a Common Otter (*Lutra vulgaris*), British, presented by Mr. A. P. Ashburnham; three Hairy-footed Jerboas (*Dipus hirtipes*) from North-east Africa, presented by Miss Baird; a Green-cheeked Amazon (*Chrysotis viridigena*) from Colombia, deposited; a Collared Fruit Bat (*Cynonycteris collaris*), a Yellow-cheeked Lemur (*Lemur xanthomystax*), a Crested Porcupine (*Hystrix cristata*), two Squirrel-like Phalangers (*Petaurus sciureus*), a Red Kangaroo (*Macropus rufus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN MAY:—

May 2. 11h. 24m. to 12h. 11m. B.A.C. 4006 (mag. 5·7) occulted by the moon.
2. 21h. Jupiter in conjunction with moon. Jupiter 6° 58′ N.
6. Vesta (mag. 6·5) in opposition to the sun. In Libra.
7. 6h. 36m. α Scorpii (Antares) in conjunction with moon. α Scorpii, 1¼° S.
7. 12h. Saturn in conjunction with moon. Saturn 5° 7′ N.
11. 13h. 16m. to 13h. 51m. B.A.C. 7263 (mag. 6) occulted by moon.
13. Uranus 52′ S. of β Scorpii (mag. 3).
15. Venus. Illuminated portion of disc 0·923.
15. Mars. ,, ,, ,, 0·936.
18. 18h. Venus in conjunction with Neptune. Venus 2° 19′ N.
20. Saturn. Outer minor axis of outer ring, 18″·69.
20. Ceres 16′ N. of β Geminorum (Pollux).
22. 4h. Uranus in opposition to the sun. In Scorpio.
22. 6h. 54m. to 7h. 32m. Venus occulted by moon.
24. Encke's Comet arrives at perihelion.
29. 22h. Saturn in opposition to the sun. In Scorpio.
30. 5h. Jupiter in conjunction with moon. Jupiter 7° 1′ N.

DOUBLE AND MULTIPLE SOUTHERN STARS.—The observation of double and multiple stars in the southern heavens has never been attempted on a large scale, although several observers have turned their attention to these bodies with not very large apertures. Sir John Herschel, in his southern sweep for nebulæ and clusters, was enabled to detect over 2000 new double stars; but his chief interest was more for the close examination of the former celestial objects than for the search for double stars. Since that time the Sydney Observatory, the Cape Observatory, and the Harvard observers at Arequipa have done much to promote our knowledge of this class of southern stars. A search on a large scale has recently been undertaken by Dr. T. J. J. See, who was invited by Mr. Lowell to undertake a survey of the southern heavens for the discovery and measurement of new double stars and nebulæ with the 24-inch refractor, which had just been completed by the Clarks. In the *Astronomical Journal* (Nos. 431–432) Dr. See gives us some details of his plan of work, together with the first part of the catalogue of new double stars. In this survey Dr. See was aided by Mr. Cogshall. The observing station was first at Mars' Hill, Flagstaff; next in Mexico, in the western part of Tacubaya; and then again at Flagstaff, the telescope in each case being dismounted and re-erected.

The region of the sky embodied in this work includes the entire zone between −20° and −45°, and the more southern region swept over in Mexico lies between −45° and −65° between 4h. and 16h. Right Ascension. Dr. See states: "In the course of this work it is certain that we have examined carefully not less than one hundred thousand stars, and many of them doubtless on several occasions." All the star places have been referred to the equator and mean equinox of 1900·0, and in each case the colours are given after a terminology which was found best to describe the tints of the spectrum. To give an idea of the quality of the object-glass used, and the excellent atmospheric conditions at Flagstaff, we may mention that an object was not considered difficult unless it was below 0″·3, or fainter than the 14th magnitude for fairly wide objects. Dr. See proposes to arrange the final catalogue in two parts: the first giving the new doubles, and the second doubles recognised by previous observers. He further uses the symbol λ to denote "stars discovered at the Lowell Observatory," and an index 1 being affixed to this letter in the first catalogue, and other numbers in subsequent catalogues. When completed, this great work will prove a most valuable contribution to our knowledge of many interesting systems in the southern hemisphere.

COMET PERRINE.—The following is a continuation of the ephemeris given previously in this column:—

12h. Berlin Mean Time.

1898.	R.A. h.	m.	s.	Dec. °	′	log *r*	log Δ	Br.
April 28	0	20	32	+49	28·1			
29		25	59	49	56·0			
30		31	26	50	22·6	0·1171	0·2675	0·52
May 1		36	53	50	48·0			
2		42	21	51	12·3			
3		47	49	51	35·4			
4		53	16	51	57·4	0·1285	0·2799	0·47
5	0	58	43	+52	18·3			

THE MANORA OBSERVATORY.—In a recent number of the *Naturwissenschaftliche Wochenschrift* (Band xiii. No. 14), Herr Leo Brenner gives a condensed account of the observations made at the Manora Observatory during the past year. As usual, the observations are chiefly restricted to minute examinations of the surface markings of planets. The article is illustrated by reproductions of the observatory and instruments and drawings of the surface markings of some of the planets. Herr Brenner refers to the question that has been raised regarding the financial condition of the observatory. In his concluding remarks he adds: "For the main part my work this year will depend on whether a change occurs in the financial condition of the observatory, or whether I shall be obliged, as formerly, to waste my time in writing worthless scientific articles."

THE HARVARD COLLEGE OBSERVATORY.—The fifty-second annual report of the director of the Astronomical Observatory of Harvard College gives us an idea of the immense amount of work which is being carried on so successfully under his supervision. Not only are extensive investigations undertaken, but they are brought to completion by the liberal staff with which he is provided. After referring to the large endowment for current expenses which renders such assistance possible, Prof. Pickering adds that as regards permanent plant they are far behind other observatories even of the second class. That this will be soon remedied there is no doubt; and Prof. Pickering has the happy faculty of knowing from which direction such donations will come, for he says, "the need of modern buildings is most likely to be supplied by gifts or bequests from persons whose names should be attached to them. For instance, a library building in which the clerical work of the institution could be performed is greatly needed. A modern machine-shop to replace our present workshop would form an excellent memorial of one who had been interested in the application of the mechanic arts to scientific uses." As usual, each of the instruments has been used for extensive investigations. The east equatorial has been employed for photometric light comparisons of variables mostly with the new polarising photometer, while the west instrument has been used for similar observations of variables and comparison stars. The meridian circle and meridian photometer have also been continuously employed, Prof. Pickering having worked with the latter on 152 nights, and made 100,052 photometric settings. The researches planned for this latter instrument are, we are told, approaching completion, 860,000 measures of about 40,000 stars having been made during the last twenty years. Both the 8-inch telescopes have been used for photographing stellar spectra, the number of photographs

obtained being 6054. The 11-inch Draper telescope has been employed for photographically recording the satellites of Jupiter undergoing eclipse, and variables of the Algol type. Mr. King, who has been investigating the effects of differential refraction and flexure on the form of the photographic images, has found that an equatorial should never be driven on sidereal time, but that satisfactory images have been obtained by photographing at suitable hour angles with a mean time driving clock, the rate being wholly corrected by the refraction in right ascension. Experiments are now being made to introduce a flexure correction automatically. In this connection it is interesting to refer to the work done by Dr. Rambeau. With regard to the other departments under the direction of Prof. Pickering, we must limit ourselves here to mentioning them: namely, the Boyden department at Arequipa, where the new Bruce photographic telescope has been erected, and the Blue Hill Observatory, although they have both been contributing valuable observations during the last twelve months.

THE NATURE AND HABITS OF PLINY'S SOLPUGA.

ALTHOUGH next to nothing is known of the past history of the spider-like creatures discussed in the following pages, it is tolerably certain that since glacial times they have been confined in their distribution, so far as Europe is concerned, to Spain, Greece and South Russia. Since, therefore, they were certainly unknown to our British and Anglo-Saxon ancestors, and probably also to the early Romans, it is not surprising that the English language has no name for the group of which they are members. To the ordinary Englishman they are spiders, and as spiders or tarantulas they are usually described by travellers who have come across them in India, Egypt and elsewhere. The Greeks, on the contrary, who were doubtless acquainted with the species inhabiting their own country and Asia Minor, seem to have recognised them from the ordinary spider, since they had a distinctive name for each of the two groups. The spiders were called Arachne (ἀράχνη); the others Phalangium (φαλάγγιον), in allusion to their five pairs of long-jointed limbs. Ælian, for example, tells how a country in Æthiopia was deserted on account of the appearance of incredible numbers of Scorpions and Phalangiums. But Pliny, when quoting the same story, introduces Solpuga[1] in place of Phalangium. And since the latter is now used in systematic zoology for a totally different group, namely for the so-called Harvest or Long-legged Spiders, so abundant throughout Europe, no further reason need be given for adopting Pliny's name for the species now under discussion.

So much by way of preface. But before leaving the ancient history of the Solpuga, it may be interesting to mention a suggestion that has been made to the effect that the Hebrew word translated Mouse in the Old Testament referred to some sort of Solpuga; and that the sores, the emerods (hæmorrhoids), from which the Philistines suffered, resulted from the bites of these creatures. In support of this supposition may be urged the unmistakable resemblance to mice presented by some of the smaller, dark-coloured, short-legged species, with their hairy bodies and rapid movements, which occur both in Egypt and Syria; and the statements of travellers to the effect that at the present time they inflict painful bites upon people when asleep in the desert at night.

It is beyond the scope of the present article to deal with the many points of interest connected with the anatomy of these animals. Nor is it necessary to point out all the distinctive features which serve to separate them from the true spiders, the only members of the class Arachnida with which they are likely to be confounded. Suffice it to say that the term spider, doubtless a corruption of spinner (spinster), is technically applied exclusively to the familiar web-spinners, and that no silk glands exist in any members of the order Solifugæ.

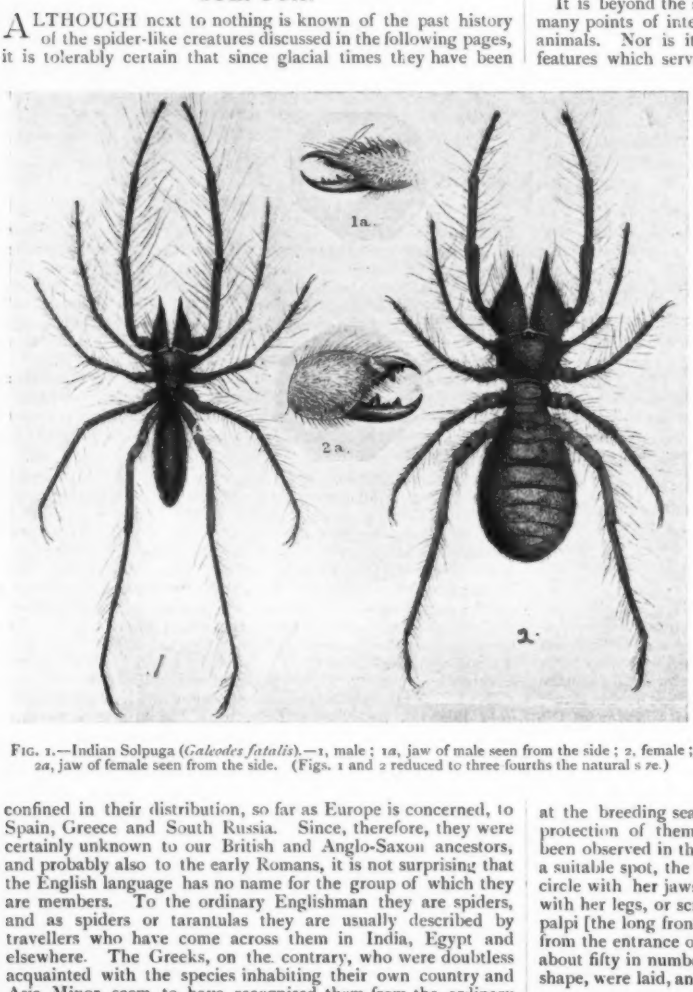

FIG. 1.—Indian Solpuga (*Galeodes fatalis*).—1, male; 1*a*, jaw of male seen from the side; 2, female; 2*a*, jaw of female seen from the side. (Figs. 1 and 2 reduced to three fourths the natural size.)

The general form is well shown in the annexed illustration depicting the male (Fig. 1) and the female (Fig. 2) of a North Indian species called *Galeodes fatalis*. As will be seen, the sexual differences are very striking, the male being both smaller and lighter in build, with the head narrower and the jaws less bulky; the legs, on the contrary, are unmistakably longer. This correlation between lightness of body and length of limb points to much greater activity on the part of the male, a superiority which no doubt stands him in good stead at the pairing time, when the female has a habit, it is alleged, of killing and devouring her less powerful mate. Again, in addition to being smaller, the jaws of the male (Fig. 1*a*) are always less strongly toothed than those of the female (Fig. 2*a*), and are furnished on the upper side with a peculiar organ of unknown function called the *flagellum*.

In both sexes, but especially in the female, the jaws attain a development unequalled elsewhere in the class Arachnida (Spiders, Scorpions, Solpugas, &c.). They are, in fact, admirably adapted for the purpose of crushing hard-shelled beetles and other insects. But they also have another duty to perform, namely, that of digging; for the females, at least at the breeding season, excavate subterranean burrows for the protection of themselves and their young. The process has been observed in the case of the species here figured. Choosing a suitable spot, the female proceeded to cut away the earth in a circle with her jaws, then kicked away the loosened fragments with her legs, or scraping them together into a heap with the palpi [the long front pair of legs], pushed the pile by main force from the entrance of the burrow. At its opposite end the eggs, about fifty in number and resembling a mustard-seed in size and shape, were laid, and hatched about a fortnight afterwards. For

[1] This word is, perhaps, a corruption of *Solifuga* or *Solipugna*, which seem also to have been in use. The former means a creature which flees from the sun; the latter one that battles against it, and so hates or is intolerant of it.

three weeks the young showed no sign of movement. They then moulted for the first time and started to crawl about on their own account, little copies in miniature of their mother, who mounted guard at the entrance and resolutely repelled all intruders, snapping without hesitation at every object thrust into the burrow.

Some species of Solpuga are known to be diurnal, and have been met with roaming abroad in the full glare of the tropical sunshine. From this habit they are known to the Spaniards of Santiago as "Arañhas del Sol" (sun-spiders). For the most part, however, they are nocturnal, and in certain localities favourable to their development prove a great nuisance to travellers camping out. Olivier, for example, describes how they would come into his tent in Mesopotamia at night, attracted by the light; and Mr. Guy Marshall informs me that an acquaintance of his, when encamped on the Hartley Hills, Mashonaland, was forced to shift his quarters on account of the invasion of his tent by a number of enormous spiders, evidently, from his description, a large Solpuga, which entered at night when the lamp was burning and rushed about at lightning speed. In such occurrences as these is doubtless to be found the substratum of truth upon which Ælian based his story of the desertion of the tract in Æthiopia on account of the Scorpions and Phalangiums.

Nothing in the way of animal life, provided it be of suitable size, comes amiss as food to the Solpuga, which is strictly carnivorous in diet. It is true that stories are told of the killing and eating of small vertebrates, like lizards, mice, birds, and bats. Nevertheless the staple article of their diet no doubt consists of insects of various kinds, ranging in size from ants to moths, beetles, or grasshoppers. A species which frequents the houses in Denver, Colorado, is said to be of service to mankind on account of its partiality for bed-bugs, a fact of some interest as showing that the strong stench of cyanide of potassium emitted by these parasites is no protection against the attacks of the Solpuga. Another kind living in Mashonaland, and known as *Solpuga sericea*—an elegant little species striped black and yellow, with long silky white hairs upon the hind legs, which, when running, resembles a tuft of thistle-down blown before the wind—feeds largely upon white ants; though Mr. Guy Marshall, my informant concerning its habits, has noticed that they eat jumping spiders of the family Attidæ, as well as small moths and beetles. When searching for food they may be seen running about at a great pace in the hot sunshine, and every now and again stopping to rest for a few seconds beneath the shade of a stone or leaf, only to rush off again without the least warning. Often when going at full speed they will stop abruptly and begin hunting and feeling around a small spot, irresistibly calling to mind the behaviour of a dog checked in mid-course by the scent of game. The white-ants they feed upon belong to a species which, instead of making a mound, builds mud tunnels along the surface of the ground amongst dead-leaves and sticks. Upon discovering such tunnelling the Solpuga follows it up, carefully examining it all the way, then suddenly breaks through the mud-wall and extracts a white ant. But whether the proximity of the insect is discovered by hearing or scent is at present unknown. This species is an expert climber, and has been seen to ascend trees to some height above the ground in search of prey. Similar stories are told of the climbing powers of other species from different parts of the world; and Mr. A. Carter informs me that in Egypt it is no uncommon thing to see a Solpuga (*Galeodes arabs*) climbing on to a table to get at the flies. To capture such quick and wary insects the Solpuga adopts the tactics of the hunting-spider; instead of making a furious dart, as it would if the prey in sight were a beetle, it proceeds to stalk the flies in the most wary fashion, creeping towards them with such slowness and stealth that the movements of the legs are almost imperceptible, yet all the while drawing gradually nearer and nearer; then like a flash of light the intervening space is traversed, and the insect struck down and captured.

Even in the case of so redoubtable an adversary as a scorpion, there is no hesitation on the part of the Solpuga in advancing to the attack. J. G. Wood tells us how at the outset of one such encounter the Solpuga by good fortune severed at one snap the scorpion's sting, and made short work of him afterwards. Nevertheless such an end to the contest is the exception rather than the rule; for in addition to some evidence on this head supplied by Mr. Trimen, Mr. Carter informs me that he has repeatedly witnessed encounters in Egypt between the common Solpuga (*G. arabs*) and the sand-scorpion of that country (*Buthus quinque-striatus*); but though the two are well matched for size, the scorpions never came off second best, in spite of the incomparable advantage in point of activity enjoyed by their adversaries.

Striking is the difference in appearance between a Solpuga fasting and a Solpuga full fed. In the former the abdomen shrivels up, the segments shrinking one within another like the several pieces of a half-closed telescope; in the latter the expansion is carried to such an extent that the distended abdomen much resembles a short thick sausage, far surpassing in size and weight the rest of the body and limbs. This is brought about by the imbibition of water and of the fluid and semi-fluid tissues of their prey. In support of their water-drinking propensities, the following passage, written by the Soudan war correspondent to the *Standard* (October 19, 1897), may be cited: "One day in my tent [at Kerma] I heard a rustle like that of a silk dress. A big, ugly, yellow hairy beast, with nippers like a crab, was moving fast as a mouse over the moist ground near the zeer [porous water jar] in the corner of my tent. At last he settled down to suck the water from the sides of the jar." The writer of the passage just quoted had previously spoken of this animal as the "famous abu-shabat, the terror of the Soudan in the way of spiders, as large as your hand and ten times more venomous than a scorpion."

This question of the poisonous nature of the Solpuga's bite is one that has attracted much attention. There is no doubt, however, that in the strict sense of the word they are not venomous at all. Nevertheless the jaws of the larger species are capable of giving a nasty and painful bite, and it is intelligible that a severe sore of long duration might result from such a wound if the Solpuga had been previously feeding upon septic matter, or if the sufferer were at the time addicted to scurvy or were in a weak state of health from any other cause. This, quite apart from other reasons, is sufficient explanation of the fact that the native inhabitants of almost all the countries where these animals are found look upon them with horror and fear on account of their alleged ferocity and venom. The natives of Somaliland, however, seem to be an exception to the general rule, for although the Solpugas are remarkable for size and abundance in that country, the Somalis, writes Mr. Parkinson, do not regard them as noxious, and have no names for things so unimportant. The dwellers in Baku on the Caspian, on the contrary, declare the Falangé [*Galeodes araneoides*] to be especially poisonous after emerging from its winter sleep, and, according to Mr. Rowland, believe that to counteract the effects of the poison it is necessary to rub the wound with the carcase of the Solpuga after first steeping it in boiling oil. Perhaps it is needless to explain to those who know the Asiatic that our subjects in Hindostan are firmly convinced of the deadly nature of the Jerrymanglum.[1] The opinion of these people on such a matter, however, is of no great value, as the following circumstance shows. Mr. H. R. P. Carter, when living at Madras, repeatedly, as he tells me, allowed the Solpuga, in the presence of natives, to bite his arm until the blood ran, without suffering anything worse than a passing pain from the wound. But although his experiments proved conclusively to himself the harmlessness of the bite, they were not sufficient to make the onlookers alter their judgment one whit. In confirmation of Mr. Carter's conclusion it may be added that Mr. J. ffolliott Darling has also had the fortitude to make similar experiments on himself, and has attained similar results, with species that are found in South Africa.

Of their enemies we know but little. From an observation made by Mr. Distant, who, while in the Transvaal, saw a wagtail attacking a specimen of *Solpuga hostilis*, a small species which is abundant in that country and in Natal, it may be inferred that they are eaten by insectivorous birds, and probably also by some mammals and reptiles. So, too, may it be supposed that the larger kinds of Solpuga destroy the smaller, and that all, both great and small, fall victims to large and medium-sized scorpions, to say nothing of great spiders and carnivorous ground beetles, many of which would certainly be powerful enough to overcome the weaker species.

It must be remembered, too, that although when fasting their agility is amazing, and their chances of escape correspondingly great, yet when gorged with food, as described above, and practically unable to trail their distended bodies behind them,

[1] This name for the Solpuga in the Tamil language I venture to spell as I have heard it pronounced.

they would fall easy victims to enemies much weaker and slower than themselves.

On the other hand, we learn from Dufour that the species found in Algeria are exempt from the attacks of the Mason wasps, which, as is well known, in that and in all countries fearlessly attack and destroy numbers of the largest spiders, and could, without difficulty, catch the fleetest Solpuga in the world. The reason for this freedom from persecution is not quite clear, unless it is to be explained by the fact that the Solpuga is too formidable a foe for the wasp to tackle. That this may well be the case is rendered intelligible by the reflection that the large lycosiform and mygaloid spiders fall easy victims because, owing to feebleness of vision and lack of activity, they are not quick enough to elude the final swoop of the wasp. The Solpugas, on the other hand, as compared with the spiders, are exceedingly agile and keen-sighted. Moreover, when on the defence, they have a habit, as described by Dr. Walter, of turning up the abdomen, so as to protect that vulnerable part, and extending the legs forwards and upwards in such a way as to present to the foe a pair of gaping jaws surmounted by five pairs of strong limbs armed with long bristles, stout spines and sharp claws. Small wonder if under the circumstances the wasps think discretion the better part of valour.

The last peculiarity to be mentioned is the presence on the inner surface of the jaws of some strong horny ridges, which by mutual friction emit a harsh grating noise. In some genera these ridges are scarcely at all developed: in others they are very pronounced. That the sound is produced in the way described under the stimulus of sudden fear or irritation was long ago pointed out by Hutton, and even before him by Pallas; and, touching its function, one can only suppose that, like analogous organs found in the rattlesnake and in some of the largest spiders and scorpions, it acts as an advertisement of the whereabouts of the Solpuga, and as a warning to enemies to keep a respectful distance. R. I. POCOCK.

THE LABOULBENIACEÆ: A NEW FIELD OF STUDY AMONG FUNGI.

THE knowledge of most botanists of the group of Fungi here under treatment is probably confined to the brief description given of them by De Bary, under the head of "Doubtful Ascomycetes," where Peyritsch's figures of *Stigmatomyces Baeri* are reproduced.

Since 1884, when De Bary's "Fungi" appeared, the investigation of the group has, however, proceeded apace; and whereas at that time hardly more than a dozen species had been distinguished, Dr. Thaxter considers that no fewer than 150 species belonging to 30 genera are now known. Almost all of these additions are due to Dr. Thaxter's investigations, and have already been announced, from time to time, in a series of papers emanating from the Cryptogamic Laboratory of Harvard University.

The first to observe one of these Fungi was probably the entomologist Laboulbène, in whose honour *Laboulbenia rougetii* was named by Montagne and C. Robin. The earliest description came from Robin in the "Histoire Naturelle des Végétaux Parasites" in 1853. H. Karsten (1869) and Peyritsch (1871–75) followed with a more detailed treatment of the morphological characters of the group, and still later Berlese, Giard, Istvanffi, and Thaxter, have in turn added to our knowledge of the family.

The Laboulbeniaceæ are, without exception, entomogenous, and occur upon species of beetles and flies almost exclusively. They are attached to the chitin of the insect by only a minute foot, by means of which, however, they absorb all the nutriment they require for their development. Upon examination with a hand-lens, they have the appearance of hairs or bristles of a dark colour, standing out vertically from the substratum. As they seldom exceed half a millimetre in length, it is not surprising that they easily escape the notice of entomologist and mycologist alike.

Their morphological characters present features of unusual interest, inasmuch as they seem to exhibit a marked sexuality, and that of a peculiar type. The male cells are non-motile spermatia, arising for the most part endogenously, but in certain genera abstricted exogenously, as in the case of the Florideæ. These spermatia become attached to trichogynes, whose cell-wall appears to have the same gelatinous consistence as have those of the Florideæ. In some genera, these trichogynes become branched and multicellular; in a few cases they bend over to come into contact with spermatia *in situ*, and then straighten again, carrying off a detached spermatium. Bearing the trichogyne is a "trichophore," itself resting on a "carpogenous" cell. From this latter there are ultimately budded off four or eight asci, each containing, when mature, four or eight usually septate ascospores, the whole being enclosed in a fusiform fructification, recalling the perithecium of a Pyrenomycete. It seems impossible to resist the impression that the asci arise as the result of an act of fertilisation, though the details of the process have not been observed. That the Laboulbeniaceæ are to be included among Ascomycetes can no longer be doubtful, and their morphology, when considered in connection with the observations of De Bary, Janczewski, Stahl, and more recently Harper, lend support to the view that sexuality persists in this class of Fungi It is difficult to imagine how otherwise Brefeld can account for the structure of Laboulbeniaceæ, when his researches have extended thus far.

The similarity in the method of fertilisation with that existing in Florideæ is very marked. For the occurrence of a receptive trichogyne and detached non-motile spermatia among Fungi, Stahl's observations had already prepared us, though it has been denied that the structures called by these names in Collemaceæ, have the sexual significance they have been shown to have in Florideæ. The analogy of the similar organs in Laboulbeniaceæ with those of Florideæ would seem to be beyond doubt. A further startling analogy with Florideæ is found in the occurrence of a single conspicuous pit in the walls separating successive cells of the hyphæ; and, as in Florideæ, these have already been utilised in tracing the genetic connection of the cells of the thallus. Although Thaxter, on account of these similarities, does not regard the derivation of Laboulbeniaceæ from Florideæ, as unworthy of consideration, it is improbable that they indicate anything more than similarities of adaptation, which often occur in widely separated groups.

Of the 250 different species of insects on which these Fungi have been found parasitic, 241 are Coleoptera, and of these the majority are aquatic or riparian in habit. Of the 7 dipterous host-species one is the common house-fly, which is frequently infested with *Stigmatomyces Baeri* in the neighbourhood of Vienna. The single termite affected came from Africa, and the single acarid from Paraguay. Though most of the Laboulbeniaceæ yet described are exclusively North American, 19 European species are known, and some accompany their hosts into two or three continents. It is probable that the family will be found to be numerous in species, and widely distributed in range. No British locality for a single species is given in Dr. Thaxter's work, and no British writer seems to have yet made any contribution to the literature of the group. In Dr. Cooke's "Vegetable Wasps and Plant Worms," published in 1892, the species then described by Thaxter and others are enumerated, but no discovery of any of these in Britain seems to have been known to the author. It is highly improbable, however, that none of the parasites occur on any of the more than 3000 British species of Coleoptera.

Though these plants do not at present appear likely to become of any economic importance, yet it is clear that they are of exceptional morphological and physiological interest; and Prof. Thaxter has earned our gratitude for the persistence with which he has pursued their study, and for the ability and skill with which he has described and portrayed them. The work forms a worthy successor to the author's monograph on "The Entomophthoreæ of the United States." R. W. P.

THE BOLOMETER.[1]

IN the number of the *American Journal of Science* for March 1881, there appeared an article descriptive of the actinic balance (since called the Bolometer), an instrument which has gained acceptance among physicists as a useful aid in the study of radiant heat. It was, it may be remembered, originally devised by the writer to discriminate the heat in any small portion of the grating spectrum, but it has since found wider applications.

[1] Reprinted from the *American Journal of Science*, April. (Communicated by the Author.)

[1] "Contributions towards a Monograph of the Laboulbeniaceæ." By Roland Thaxter. (*Memoirs* of the American Academy of Arts and Sciences, vol. xii. No. 3, December 1896. Pp. 242, pls. 26.)

As at first constructed, the strips, representing arms of the Wheatstone bridge, were made of iron from 0·001 to 0·0001 of an inch in thickness. The instrument was, even under these initial conditions, very many times as sensitive as the best thermopile the writer then possessed, but there does not appear to be any definite statement as to the exact sensitiveness in its early form.

In the article referred to, however, the instrument is represented as giving a deflection of about 40 scale divisions (millimetres) from the lunar heat, concentrated by a thirteen-inch lens, and it was sufficiently accurate to give a probable error of rather less than one per cent. for a single observation on a constant source of heat, so that the accuracy of the bolometer (quite a distinct consideration from its sensitiveness) was even then as great as that of the best photometric process. The galvanometer in use at that time was one of the early Thomson pattern made by Elliott.

The first bolometers were made by the writer's own hands. Subsequently the strips were usually cut out from sheets of thin platinum, and in one or two instances made from flatted wire, the strip of the linear bolometer at that time (about 1883) being usually about 10 millimetres long; anywhere from 0·001 to 0·01 of a millimetre thick, and, according to its special purpose, being made from 1 millimetre to 0·1 millimetre wide.

About 1886 the mounting of the instrument had been improved by the writer, so that the strip appeared like the vertical "wire" of a reticule in the focus of a positive eyepiece. It was also movable in some cases by a micrometer screw, and was, in fact, a micrometer thread controlled in the usual way, but endowed with the special power of feeling the radiations from any object on which it was directed.

In the earliest spectrum work the bolometer developed another important quality, its "precision." This quality is quite independent of the accuracy with which it repeats measures of radiation or any constant source of heat, and concerns the precision of setting, as a micrometer thread. It could, even twelve years ago, be pointed, not only like the thermopile, within a fraction of a degree of the place of the source of radiation, as for instance on a bright line in the spectrum, but within a fraction of a minute of arc.

The instrument of course depends for its general efficiency on the galvanometer with which it is connected. That used in 1886[1] had several improvements due to the suggestions of Sir William Thomson and Prof. Rowland, and was perhaps, at that time, the most effective instrument of its kind in use for such a purpose, the mirror and needles having been specially constructed at the Allegheny Observatory. The mirrors were platinised by the kindness of Prof. Wright, and were at that time nearly a centimetre in diameter. The needles were hollow magnets made by Mr. Very of the Allegheny Observatory. For the damping mechanism of the older galvanometer, I had substituted a dragon-fly (*Libellula*) wing, in which nature offers a model of lightness and rigidity quite inimitable by art. At that time, when making a single vibration in 20 seconds, a deflection of one millimetre division of the scale at one metre distance was given by a current of 0·000,000,0005 amperes, the instrument as described being capable of recording a change of temperature in the bolometer strips of less than 0·00001 of a degree Centigrade. So much less than this could be observed by special precaution, that it might be said that this one one-hundred-thousandth of a degree was not only indicable but measurable by the apparatus, which was employed as described, in the determinations of the relations of n to λ for the rock-salt prism, and by which the infra-red spectrum was at that time followed by actual measurement, to a wave-length of rather over five one-thousandths of a millimetre.

Since then the bolometer has been used in various researches, of which some occasional account has been given in the *American Journal of Science*. (See numbers for November 1888, and August 1890.) During recent years it has been specially employed in making a bolographic map of the lower spectrum, the publication of which has been greatly delayed by conditions incidental to the relations of the Smithsonian Observatory with the Government, but which it is hoped will not be deferred much longer.

Without here entering into an account of the work done by it, I have thought that it might be of interest to give very briefly a statement of the present condition and form of the instrument itself, considered under three aspects.

[1] *American Journal of Science*, third series, vol. xxxii. p. 90, 1886.

(1) Its precision, or the degree of exactitude with which it can be set on a special point, as, for instance, on a line of the invisible spectrum, recognised by its heat radiation alone.

(2) Its accuracy, or its capacity for repeating the same measure of radiation under like conditions.

(3) Its sensitiveness, or capacity for detecting minute radiations.

The instrument which I will take as the subject of comparison with the earlier one as described in this *Journal* (August 1886), is now in use in a chamber automatically kept at a temperature constant within one-tenth of a degree Centigrade.

The strips, the essential part of the instrument, are in the present case made by Mr. C. G. Abbot, and are of platinum, the central one being rather less than 0·1 of a millimetre wide. (The case is now made of metal instead of ebonite, and is surrounded by a current of water).

It is quite possible to make bolometer strips much narrower, but this is less necessary with the employment of the long-focus, image-forming mirror, so that in the present case the strip is at such a distance that it subtends an angle of 3·4 seconds. Its angular aperture is in practice adapted to that of the slit, which, with the use of the long collimator employed by the writer, gives a capacity of pointing (pointing, that is, *in the dark*), with a probable error of little over a second of arc. Quite recently, owing to the use of a novel collimating system of two cylindrical mirrors proposed by Mr. Abbot, the slit, though at a moderate distance, can have an opening sufficient to avoid prejudicial diffraction effects, while subtending an angle of considerably less than one second of arc.

In the galvanometer, the use of the fine quartz threads and specially small mirrors, originally due to Mr. Boys, has lately been carried to what seems near the practicable extreme, the quite invisible thread being made some 30 centimetres long, the mirror 2 millimetres in diameter, and weighing but 2 milligrams, and its six needles, of proportionate weight and dimensions.

This system is now made to serve with a much shorter swing than that formerly employed. If we reduce it to a time of single vibration of 20 seconds, only for the purpose of comparing it with the values already given in the earlier form, we obtain the results submitted below.

Before giving them, however, it is to be mentioned that the apparatus at Washington is most unfavourably situated, owing to its being subject to tremor from the traffic of neighbouring streets and to other causes, which it has been the object of years of struggle to conquer. This has been so far done that the values presently to be given (which, it will be remembered, are only attainable in a chamber of constant temperature, with special precaution against disturbance from external tremor), can be counted on as real values, always obtainable under proper conditions, and, in fact, rather within than without the average working capacity of the instrument.

I here consider the bolometer as at present employed.

(1) With regard to its precision, or exactness of pointing. The old thermopile could be set on a portion of the spectrum only with an error of a considerable fraction of a degree. The linear bolometer as employed in 1886 could be set with a probable error of a fraction of a minute of arc. The bolometer as employed to-day, and moved through the spectrum by clockwork, can be automatically set with a probable error of a single observation of little over a second of arc, can be set, that is, in the dark with a precision little inferior to the capacity of the eye in setting a micrometer thread in the light.

(2) As to its accuracy. I have had occasion recently to take a series of measures of successive throws of the galvanometer, using as a source of heat an Argand petroleum flame in a common student's lamp. I had no photometer at hand, but taking the usual statements of the text-books as to the accuracy of vision, it might be expected that such measures with the eye would give a probable error of about one per cent. (This is where sources of light of similar quality are compared.) The probable error of a single galvanometer reading was between 0·03 and 0·04 of one per cent., and this included the fluctuation of the intensity of the source of radiation, and the error of estimating tenths by the reader on the scale, both quantities of nearly the same order as the error in question. It seems safe to say, then, that *no* error attributable to inaccuracy of the bolometer could be detected by the means employed.

(3) As to sensitiveness. In the early work, for a time of single swing of 20 seconds, a deflection of one millimetre with

the scale at a metre's distance was obtainable with a current of 0·000,000,0005 of an ampere. At present, under such circumstances, a similar deflection would be obtained with 0·000,000,000,0012 ampere, that is to say, the apparatus is about 400 times as sensitive as it was when first described.

At present the bolometric apparatus, under the conditions already cited, will indicate a change of temperature in its strips of, at any rate, much less than one-ten-millionth of one degree Centigrade. S. P. LANGLEY.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MRS. PHEBE HEARST has offered to erect for the University of California a new building for the School of Mines.

DRAUGHTSMEN and engineering students familiar with the principles of the science of steam, are given opportunity of advancing their knowledge by a special class in steam-engine trials which will commence at the South-Western Polytechnic, Chelsea, on May 17, and terminate on June 28. The class will be conducted by Mr. W. W. F. Pullen and Mr. H. A. Clark.

THE trustees of Cornell University have just established a Medical Department and a State College of Forestry. The medical department will be situated in New York City, and its faculty will be made up principally of those surgeons and physicians who have heretofore been connected with the medical department of New York University; including all but three of the instructors of that department. The endowment of the new medical school is by a donor whose name is not disclosed. The College of Forestry established by Cornell University will be situated at Ithaca, and called the State College of Forestry, having been authorised and endowed by the State with a grant of 10,000 dollars by the legislature which adjourned a few days ago. Prof. Bernard E. Fernow, director of the United States Division of Forestry, has been made director of this department.

ONE of the most important educational problems at the present time refers to the coordination of the work of the University and Technical Colleges with that of other educational institutions in the neighbourhood. It is unfortunate that in several cities the educational institutions are competing with one another instead of working together as an organic whole, in which each part has a definite function to perform. Efforts are, however, being made in the large provincial centres to prevent the undesirable overlapping which at present exists, in order to make the various educational institutions complement each other's work without competition. Summaries of what has been done in this regard at Birmingham, Manchester, Plymouth, and Sheffield appear in the current number of the *Record of Technical and Secondary Education*. In Birmingham, though no formal machinery exists for the coordination of educational work, the various institutions have adapted their organisation to the circumstances of their environment, supplying any need that was felt, and avoiding duplication of function. An educational ladder has, in fact, been constructed, up which a boy may climb from the Board School to the highest University honours without exciting the jealousy of other schools than those which he attended. This event actually occurred last year, when Mr. W. H. Austin, who began his education at a Birmingham Board School, came out Senior Wrangler at Cambridge. In Manchester the provisions for coordination take the form of an agreement between the Technical Instruction Committee of the City Council and the School Board, and between the authorities of Owens College and the Manchester and Salford Technical Schools. As between Owens College and the Technical Schools it is arranged that the latter shall aim at demonstrating how the general principles of science and art may be applied to the advancement of trade and industry, whilst the college will eschew these obviously bread-and-butter subjects, and address itself to the higher walks of pure science. In Plymouth, also, a scheme has been arranged which correlates and connects the whole of the science and art teaching of the town, from the infant school upwards. In Sheffield a scheme which secures the effective coordination and economical management of the Board Schools, the Technical School, and the School of Art, has been at work since last September, and appears to give entire satisfaction to all concerned; and Bradford has just taken steps to grade its various educational forces. Through all the schemes one main principle runs—that, namely, of making the common schools, Primary and Secondary, the kindergarten and nursery of science and art, and of making the Technical Schools true to their name as the places where is taught the application of science and art to the purposes of industry and commerce, while to the University Colleges are allocated the higher scientific studies. These examples should encourage other county boroughs to consider and adopt educational schemes which will prevent waste of effort and do away with conflicting interests.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, April 22.—Mr. Shelford Bidwell, F.R.S., President, in the chair.—A paper by Prof. T. C. Porter, on a method of viewing Newton's rings, was read by Prof. S. P. Thompson. If a parallel beam of light from a rectangular slit falls at oblique incidence upon a plane plate of glass, the first two reflections occur at the upper and lower surfaces of the glass, respectively, and give two corresponding images that may be formed on a screen. If now a second glass plate is added below the first, and parallel to it, at a short distance, four images of the slit appear on the screen. But when the lower plate is brought into contact with the upper one, the reflection from the lower surface of the upper plate follows the same path as that from the upper surface of the lower plate, so that only three images are now to be distinguished. For the two glass plates the author substitutes a "Newton's rings" apparatus, and by the above device for eliminating a set of reflections he is able to restrict the illumination to the light that comes from the two interior surfaces. As thus observed, the colours of the rings are very brilliant. When the plates are very clean, the darkest area of the "black" spot has a sharply-defined edge, similar to that of the black film of a soap-bubble. By using monochromatic light, the various sets of rings may be photographed; they appear as several systems of concentric circles, the systems intersecting one another. This method of illumination by a slit, enables Newton's rings to be viewed free from all light except that due to reflections at the bounding surfaces of the air-space between the plates. It reveals to the eye the subordinate interference—systems that coexist with the primary rings, and it demonstrates which of these reflections must be taken into account in the theory of the phenomenon. Moreover, it supplies a means for analysing these systems, and it indicates that the interference of monochromatic light is never complete under these circumstances. Prof. Herschel said it was rather difficult to follow the arguments of the author without witnessing the phenomena. Much complication was introduced by the successive reflections; it was not clear what became of them. There was no doubt as to the advantage of a narrow slit for the illumination. He thought some of the secondary reflections might be got rid of by using plates that were slightly prismatic. Prof. Thompson had, in his own laboratory, verified the advantages of the author's method of illumination. The result was a very sharply-defined first system of rings. Curves of subordinate interference were easily to be observed by this arrangement. Prof. Boys noticed in the photograph of the ring-systems that the independent systems of bands were distorted at the points of intersection. The intersecting curves formed a sort of honeycomb, or hexagonal system, instead of a system of curvilinear quadrilaterals. This distortion reminded him of similar effects observed in the photographs of "ripples." Mr. Edser said he had often noticed similar distortions, but he had always been able satisfactorily to explain them as being the result of imperfect focussing. The author had referred to the fact that a thin film when viewed by reflected light appears black. A phase-change of half a wave-length takes place either on reflection at a rarer, or at a denser medium; but there is no information from which to decide between these two alternatives. The truth of the assumption that the phase-change occurs at the denser medium seems to depend, so far as experimental evidence is concerned, upon the observation that in Lloyd's bands the central one is black. To produce the Lloyd's bands only one mirror is used; the bands produced by Fresnel required three mirrors. Wernicke performed an interesting series of experiments in which white light reflected for various angles of incidence from a thin sheet of glass was examined spectroscopically. The spectrum was crossed with numerous black bands, and from the position of these bands in the spectrum the thickness of the glass was calculated. The calculated thickness when the angle of incidence was great, differed from that obtained with small angles of incidence; the conclusion was that when light is internally reflected, even at an angle of incidence less than the angle of

total reflection, a phase-change is produced. If the space between the two plates in Prof. Porter's experiment were filled with a substance of higher refractive index than glass, a confirmation, or otherwise, of this result might be obtained.—Dr. S. P. Thompson then exhibited a model apparatus made by the Helios Company to illustrate the three-phase method of transmitting power. It consists of a small generator, driven by hand, and a small motor. The generator is separately excited by a small secondary battery; it has three independent coils. The six ends of the coils are connected to six commutator rings. The motor has three corresponding pairs of opposite coils; these can be grouped in various ways for connection to the brushes of the generator. The six coils are on a hinged frame, so that, if necessary, they can be laid down flat, for other rotation experiments. Two armatures are provided, either of which may be used. The first is an iron wheel with peripheral copper bars arranged like a squirrel-cage; the other is a simple iron disc without added conductors.—The President proposed votes of thanks, and the meeting was adjourned until May 13.

Zoological Society, April 5.—Lieut.-Colonel H. H. Godwin-Austen, F.R.S., Vice-President, in the chair.—Prof. Sydney J. Hickson, F.R.S., read a paper on the species of corals of the genus *Millepora*. The author stated that thirty-nine species of the genus *Millepora* had been described. A prolonged investigation of the characters hitherto used for the determination of the species had proved them to be all unsatisfactory. An examination of the soft parts of a great many specimens of several forms of growth and from widely distant coasts had revealed no features that could be used for separating species. In the author's opinion, therefore, there was only one species of this genus now living, and that the individuals of this species were capable of assuming a great variety of form, according to the conditions in which they lived.—A communication was read by Mr. J. Stanley Gardiner containing an account of the perforate corals collected by him in the South Pacific. Fifty-one species were treated of, of which fifteen were described as new.—Mr. Oldfield Thomas read the description of a new Dik-dik allied to *Madoqua kirkii*, but much larger, which had been obtained by Mr. H. S. H. Cavendish in the region of Lake Rudolf, and was proposed to be called *Madoqua cavendishii*.—Mr. R. Lydekker, F.R.S., made some remarks on the geographical races of the Banting (*Bos sondaicus*), and suggested that the Burmese and Manipur forms of this animal should be given subspecific rank, for which he proposed the respective names of *Bos sondaicus birmanicus* and *B. s. woodi*.

Entomological Society, April 6.—Mr. R. McLachlan, F.R.S., Vice-President and Treasurer, in the chair.—On behalf of Mr. Greenshields, Mr. Jacoby exhibited specimens of the longicorn beetle, *Micropsalis durnfordi*, Burm., from Patagonia. Mr. Greenshields, who was present, stated that this species, remarkable for the great development of the palpi, was originally taken by Darwin; his own examples were taken hiding in thorny bushes in a dry watercourse.—Mr. Champion exhibited European examples of *Harpalus fröhlichi*, a newly-discovered British species.—Mr. B. O. Bower showed living larvæ of *Caradrina ambigua*, an insect which had recently occurred in England in countless numbers. They were bred from ova laid by a female taken on the South Devon coast, and fed indiscriminately on low plants.—Mr. M. Burr read a paper supplementary to Mr. Green's previous communication on *Dyscritina*, and definitely referred the imagos to the genus *Diplatys*, *D. longisetosa*, Westw., being a good species, and Mr. Green's new form proving to be *D. nigriceps*, Kirby.—Dr. Chapman read a paper on the larva of *Eriocephala allionella*, which he stated to be essentially similar to that of *E. calthella*, previously described by him.

Linnean Society, April 7.—Dr. A. Günther, F.R.S., President, in the chair.—Mr. J. E. Harting exhibited specimens of the Asiatic partridge, *Perdix daurica*, of which a large consignment had been lately received in London. Mr. W. E. de Winton, who brought another specimen of this bird for exhibition, made some remarks on the geographical distribution of the species, and expressed the opinion that it had been improperly described by certain writers as Manchurian, its true habitat lying to the west of the Khinghan Mountains in Mongolia.—Mr. J. E. Harting also exhibited the skin and skull of a wild cat, *Felis catus*, recently obtained near Speanbridge, in Inverness-shire. He pointed out the present restricted range of the animal, which had not only disappeared entirely from England and Wales, but was no longer to be found in Scotland south of a line drawn from Oban to Ben Lui, along the southern and eastern boundary of Perthshire, and thence northward to Nairn. He explained the cause of reversion in the colour of emancipated house-cats to the wild type of *Felis catus*, and referred to the skulls of cats which had been exhumed on the site of the Roman city of Silchester, which he thought disproved the view of the late Prof. Rolleston (*Journ. Anat. and Physiol.*) to the effect that the domestic cat was not known to the Romans.—Dr. G. Elliot Smith read a paper, entitled "A contribution towards a more exact knowledge of the anatomy of the brain in Edentata." A full account of the brain of *Orycteropus* was first given, and comparisons were instituted with that of a dozen species representative of the leading Edentate families, including *Manis* and *Chlamydophorus*.—A paper was read by Mr. H. Farquhar, of Wellington, N.Z., on some New Zealand *Actiniaria*, in which he described a new genus, *Halcampactis*, and species *Halcampactis mirabilis*, together with the following new species: *Edwardsia elegans* and *neo-zelanica*; *Corynactis Haddoni*, *mollis*, and *gracilis*; and *Actinia tenebrosa*. *Halcampactis mirabilis* he regarded as of special interest, since it appeared to form a link between the *Sagartidæ* and *Halcampidæ*, which had hitherto been widely separated by systematists.

Royal Meteorological Society, April 20.—Mr. F. C. Bayard, President, in the chair.—Major H. E. Rawson, R.E., read a paper on anticyclonic systems and their movements. Cyclones and anticyclones have long been recognised as powerful weather controls, and their movements studied, but up to the present very little has been written in this country upon the progressive movements of the cores of the permanent high-pressure areas which are found to be associated with certain localities at different times of the year. The author referred to previous investigations by Abercromby, Scott, Loomis, H. C. Russell, and Buchan, and then proceeded to give the results of an examination which he had made of all the available synoptic weather charts for the eleven years 1881 to 1891. During this period there were 212 cases in which the centre or core of an anticyclonic system was over the British Isles, and of these 130 were due to the Atlantic system, 41 to the Scandinavian, and 17 to the Greenland, 22 to the Atlantic and Scandinavian systems extending and merging together, and 2 to the same thing occurring in the case of the Atlantic and Greenland systems. It is thus evident that we owe the greatest number of our anticyclones to the Atlantic system. They occur in all months, but more especially in January, June and October, and are least frequent in April and November. When such anticyclones move away from our area the direction is very much influenced by the season of the year, by far the largest number drift off in some direction between north-east, through east to south, and take the more southerly course in December, January and February. Some few between April and July move west or south-west, and still fewer north or north-west.—The Hon. F. A. Rollo Russell described the results of observations which he had made on haze and transparency during 1897. He found that the greatest clearness occurred with winds from the westward, and the least clearness with winds from the eastward. The highest mean visibility was 24 miles with the west winds, and the lowest mean visibility was 10·6 miles with north-east winds.

PARIS.

Academy of Sciences, April 18.—M. Wolf in the chair.—Expression of tidal coefficients by means of a sum of periodic terms, by M. Hatt.—On the reduction of double integrals of algebraic functions, by M. Emile Picard.—On some derivatives of tetra-methyl-diamido-benzophenone, by M. E. Grimaux. The dinitro- and dibromo-derivatives are described, and colouring matters produced from them.—Sugar and fat from the point of view of their respective nutritive value, by M. A. Chauveau. In these cases the subjects under experiment were kept at rest; the results were similar to those obtained in the previous experiments, the sugar diet being always superior to the thermally corresponding fat diet.—The committees were nominated for awarding in 1898 the prizes bearing the names of Wilde, Vaillant, Desmazières, Montagne, La Fons-Melicocq, Thore, Savigny, Montyon (medicine and surgery), Bréant, and Godard.—On the ellipsoid of Jacobi, by M. P. S. Krüger.—On the motion of a heavy body of revolution, suspended from a point on its axis, by M. E. Jahnke.—On the potential functions of the theory of elasticity, by MM. Eugène and François Cosserat.—On the transport of luminous

variations by means of a wire conducting electricity, by M. Dussaud. An application of the selenium cell.—On the influence of self-induction in the explosion by the electric spark of mixtures of marsh gas with air, by MM. H. Couriot and J. Meunier.—Influence of temperature upon chemical reactions, by M. Albert Colson. An experimental study of the effect of temperature upon the velocity of absorption of hydrogen sulphide by orthophosphate and pyrophosphate of silver, zinc phosphate, and copper phosphate.—On the ammoniacal bromides of silver, by M. Jarry. By the action of liquid ammonia upon silver bromide the two compounds $2AgBr.3NH_3$ and $AgBr.3NH_3$ are formed, the dissociation pressures of which were measured.—On the phosphoric ethers, by M. J. Cavalier. Monomethyl- and monoallyl-phosphoric ethers were prepared and their behaviour towards indicators examined. The results were analogous to those given by the corresponding ethyl ether. A table is given showing the heats of neutralisation of the three ethers by various bases.—On the alkaline sulphantimonites, by M. Pouget. The sodium sulphantimonites are formed under conditions analogous to the potassium compounds; they differ from the latter, however, by the facility with which they undergo oxidation to sulphantimoniates.—General reaction of ethylenic hydrocarbons; corresponding mercuric combinations, by M. G. Denigès. By treatment with acid mercuric sulphate, all ethylenic compounds (except ethylene itself) give yellow compounds of the formula $(HgSO_4.HgO)_3R''$, where R″ represents the hydrocarbon. Compounds of propylene, butylene, and amylene are described.—Heat of formation of some quinones of high molecular weight, by M. Amand Valeur. The quinones used were: α-naphthoquinone, β-naphthoquinone, anthraquinone, phenanthrenequinone, and retenequinone; the results are compared with α- and β-naphthols, new data for which are given.—Heats of neutralisation of ethylphosphoric acid, by M. G. Belugou.—New synthesis of 3'3-di-methyl-1'5-pentanedioic acid, by M. F. E. Blaise.—Spectrum analysis of non-conducting substances by fused salts, by M. A. de Gramont. The finely-powdered mineral is fused with either lithium carbonate, boric acid, or potassium bisulphate, the first for preference, and the sparks passed through the molten mass.—On the functions of cerebral hypophysis, by M. E. de Cyon. The slightest pressure upon the hypophysis is immediately followed by a sudden variation in the blood pressure, and by a marked decrease in the number of heart beats per minute.—Effects upon man and mice of the inoculation of a pyogenous Tricophyte, by MM. Sabrazès and Brengues.—The parasites of cancer and of sarcoma. Coloration, structure, cycles of reproduction, and dimorphism, by M. F. G. Bosc.—Contribution to the study of direct cellular division; its anomalies and functional value, by M. Joannes Chatin.—On the Annelids collected by the expeditions of the *Travailleur* and *Talisman*, by M. Louis Roule.—On a cavity in the integument serving in the *Myrmicinæ* to spread out a secretion product in contact with air, by M. Charles Janet.—Variations, in four phases, of the pressure and of the two mean components of the wind on the meridian of the sun and its orthogonal, by M. A. Poincaré.—Influence of the movements of the moon on the oscillations of the atmosphere, by M. P. Garrigou-Lagrange.

DIARY OF SOCIETIES.

THURSDAY, APRIL 28.

ROYAL SOCIETY, at 4.30.—On the Meteorological Observatories of the Azores: H.S.H. the Prince of Monaco.—A Compensated Interference Dilatometer: A. E. Tutton.—Observations on the Action of Anæsthetics on Vegetable and Animal Protoplasm: Dr. Waller, F.R.S., and Prof. Farmer.—A Calorimeter for the Human Body: Dr. Marcet, F.R.S.—An Experimental Inquiry into the Heat given out by the Human Body: Dr. Marcet, F.R.S., and R. B. Floris.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.

FRIDAY, APRIL 29.

ROYAL INSTITUTION, at 9.—Magneto-Optic Rotation and its Explanation by a Gyrostatic Medium (with Experimental Illustrations): Prof. A. Gray, F.R.S.

INSTITUTION OF MECHANICAL ENGINEERS, at 7.30.—Steam Laundry Machinery: Sidney Tebbutt.

MONDAY, MAY 2.

SOCIETY OF ARTS, at 8.—The Electric Locomotive: Prof. Carus Wilson.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—Self-intensive Refrigeration of Gases, Liquid Air and Oxygen: Dr. W. Hampson.

VICTORIA INSTITUTE, at 4.30.—British Submerged River Valleys: Prof. Hull, F.R.S.

TUESDAY, MAY 3.

SOCIETY OF ARTS, at 8.—Senefelder and the Centenary of Lithography, 1798–1898: Joseph Pennell.

ZOOLOGICAL SOCIETY, at 8.30.

WEDNESDAY, MAY 4.

SOCIETY OF ARTS, at 8.—The Revival of Hand-loom Weaving: Miss Clive-Bayley.

GEOLOGICAL SOCIETY, at 8.—The Carboniferous Limestone of the Country around Llandudno: G. H. Morton.—On the Graptolite-Fauna of the Skiddaw Slates: Miss G. L. Elles.

ENTOMOLOGICAL SOCIETY, at 8.

THURSDAY, MAY 5.

ROYAL SOCIETY, at 4.30.

LINNEAN SOCIETY, at 8.—On some Spitsbergen Collembola: Sir John Lubbock, Bart., M.P., F.R.S.—On the Structure and Development of *Soranthera*: Miss Ethel Barton.—The Species, the Sex, and the Individual: J. T. Cunningham.

CHEMICAL SOCIETY, at 8.—The Reactions of the Carbohydrates with Hydrogen Peroxide: C. F. Cross, E. J. Bevan, and Claud Smith.—The Properties and Relationships of Dihydroxytartaric Acid, Part II.: H. J. H. Fenton.—The Affinity Constants of certain Hydroxy-acids: S. Skinner.—Molecular Weights in Solution of Permanganates, Perchlorates, and Periodates: J. Murray Crofts.

FRIDAY, MAY 6.

ROYAL INSTITUTION, at 9.—Living Crystals: Edward A. Minchin.

GEOLOGISTS' ASSOCIATION, at 8.—Notes on Skye: Horace B. Woodward, F.R.S.—Observations in Lapland: Aubrey Strahan.

SATURDAY, MAY 7.

GEOLOGISTS' ASSOCIATION.—Excursion to Hillmorton and Rugby. Director: Beeby Thompson.

BOOKS, PAMPHLET, and SERIALS RECEIVED.

BOOKS.—Domestic Science Readers: V. T. Murché, Book vii. (Macmillan).—Flower Favourites: L. Deas (Allen).—A Century of Vaccination: Dr. W. S. Tebb (Sonnenschein).—Maryland Geological Survey, Vol. 1 (Baltimore).—Iowa Geological Survey, Vol. vi. (Des Moines).—Magnetismo e Ipnotismo: Dr. G. Belfiore (Milano, Hoepli).—Museums Association, Report of Proceedings &c., at the Eighth Annual Meeting held in Oxford, July 6 to 9, 1897: edited by J. Paton (Dulau).—Handbook of Jamaica, 1898 (Stanford).

PAMPHLET.—Das Physikalisch-Chemische Institut der Universität Leipzig und die Feier seiner Eröffnung am 3 Januar 1898: Prof. Dr. W. Ostwald (Leipzig, Engelmann).

SERIALS.—Journal of Anatomy and Physiology, April (Griffin).—Journal of the Chemical Society, April (Gurney).—Quarterly Review, April (Murray).—Home University, April 15 (West).—American Journal of Mathematics, Vol. xx. No. 2 (Baltimore).—Journal of the Marine Biological Association of the United Kingdom, April (Dulau).—Himmel und Erde, April (Berlin, Paetel).—Bulletin de l'Académie Royale des Sciences, &c., de Belgique, 1898, No. 3 (Bruxelles).—Wide World Magazine, April (Newnes).

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